AD-A039 095 INTEX INC CHEVY CHASE MD F/G 9/5

PORTABLE, BATTERY OPERATED WALK-THROUGH WEAPON DETECTOR.(U)

APR 77 P HOROWITZ, R J RICCI DAAG53-76-C-0032

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INTEX Inc.
6935 Wisconsin Avenue
Chevy Chase, Md. 20015
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PORTABLE, BATTERY OPERATED WALK-THROUGH WEAPON DETECTOR.

Final Report,

Project No. 1703

Data Item A007

Contract Number DAAG 53-76-C-0032 NEW

U.S. Army Mobility Equipment Research

and Development Center

Fort Belvoir, Virginia 22060

53p.

By: Peter Horowitz
Roy J. Ricci

April 1977

Approved for Public Release

410178

INTEX Inc.

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INTEX Inc.

FINAL REPORT

Project No. 1703

Contract No. DAAG 53-76-C-0032

I.0 INTRODUCTION

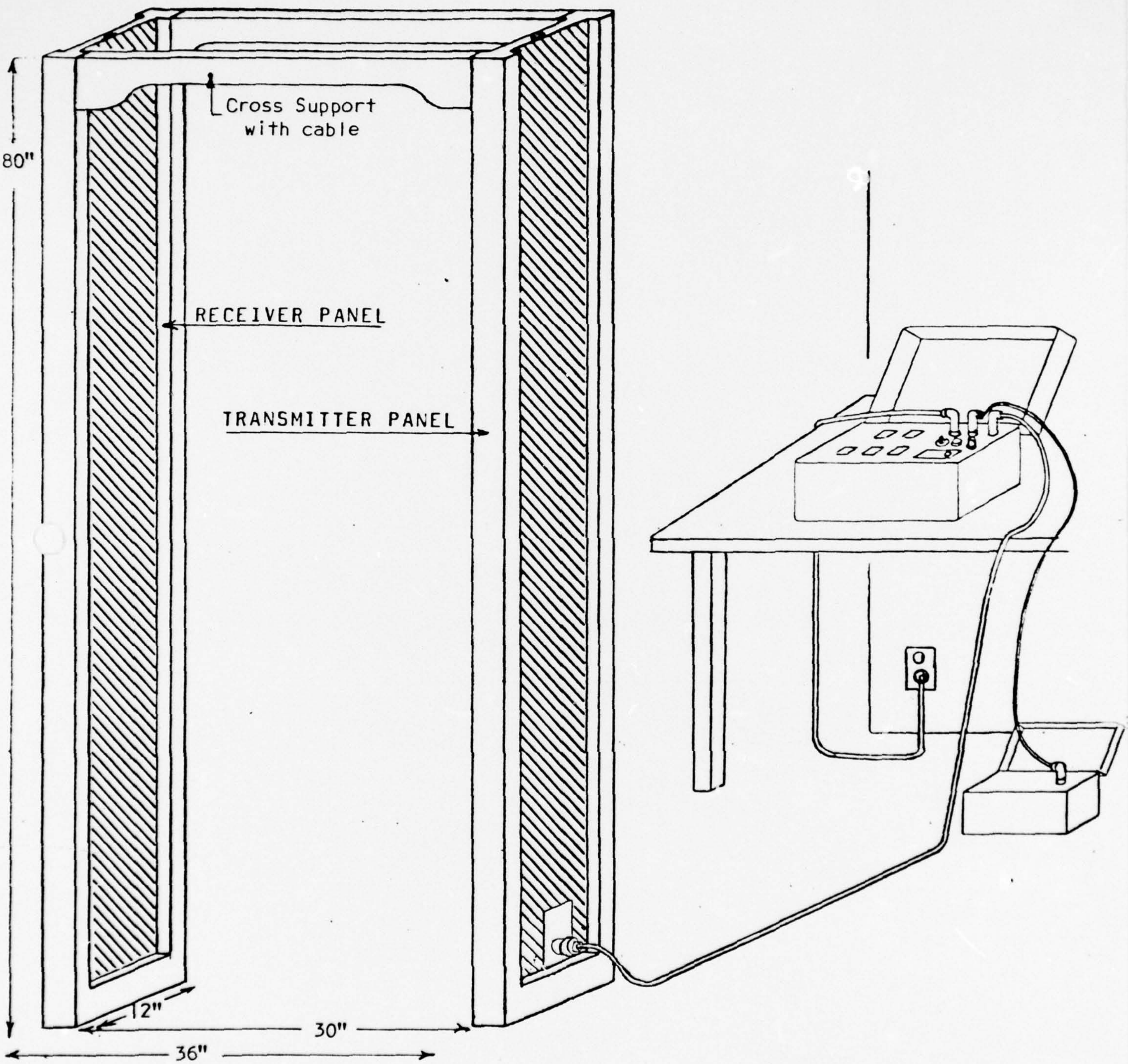
Under Contract No. DAAG-53-76-C-0032 INTEX Inc. has delivered two militarized pulsed-field weapons detectors to USA MERADCOM, Fort Belvoir, Virginia. These units were developed under the MACI program and are basically the INTEX model FS-1, repackaged into EMI, RFI and environment-proof enclosures with appropriate seals, filters and additional control functions to satisfy interface requirement to FIDS equipment. In addition, battery packs were constructed and circuitry included to provide continued system operation in the event of AC power failure.

The commercial item to be adapted to the militarized version is the Model FS-1 described in the brochure shown in Appendix I. In order to meet the requirements of the Purchase Description associated with the original RFP, a design adaptation was proposed as presented in Appendix II, which is a copy of the appropriate section of the original proposal submitted in response to the RFP. It will be noted therein that in the proposal phase, it was anticipated that a more rigid coil structure would be required to meet the shock and vibration requirements.

II.0 RESULTS

The final system which evolved as a result of the development efforts is shown in detail in Figures 1 through 4. The system consists of the three basic elements as originally defined (walk-thru archway, electronic control console, and emergency battery power pack) all cabled interconnected. In appearance, the walk-thru archway is identical to that of the commercial version. It was found during the course of the contract that the particular commercial design was acceptable for shock and vibration purposes and it was only necessary to change the bonding techniques and commercial grade connectors to military grade. Two identical units were delivered under the contract.

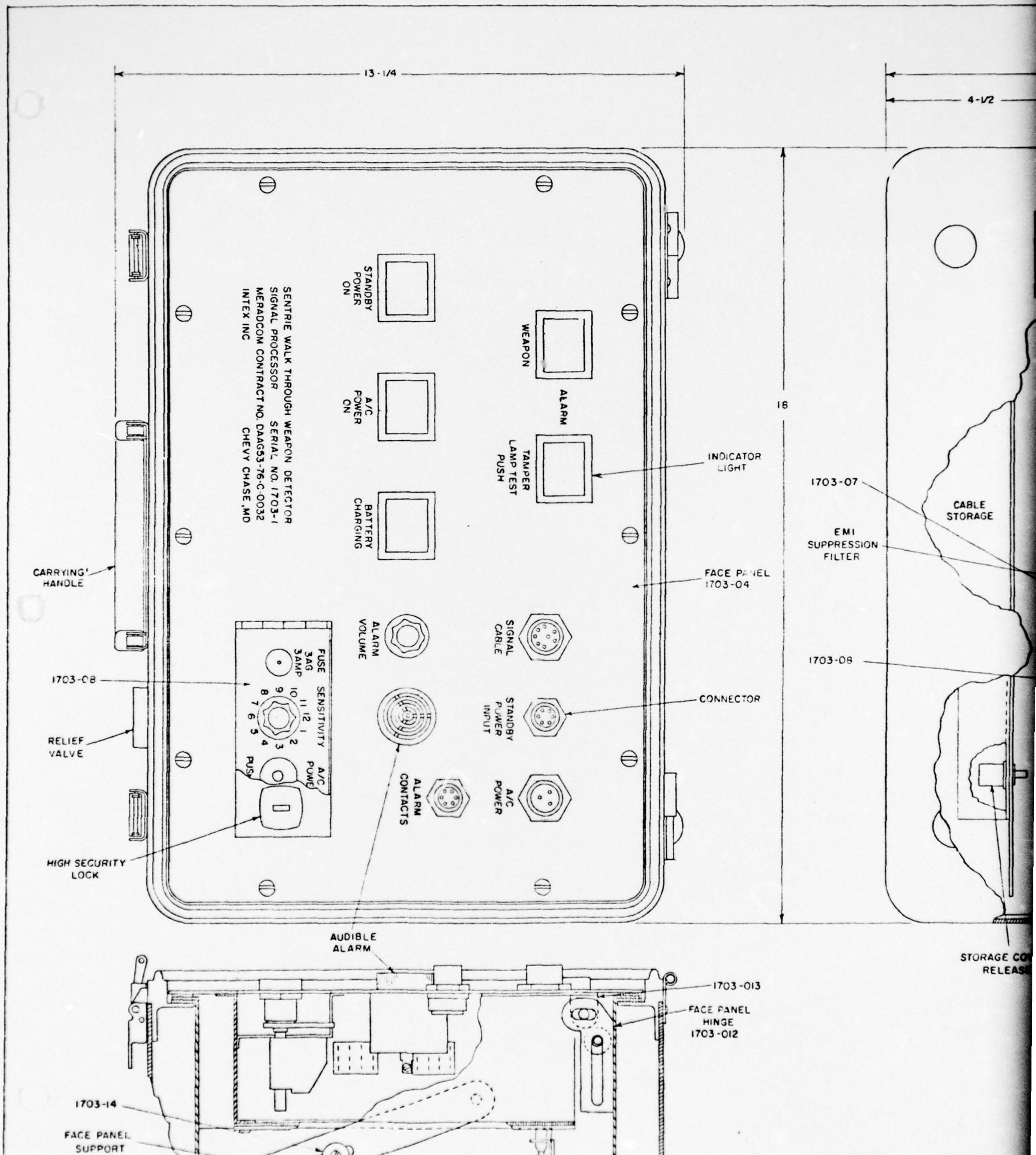
These units after testing and burn-in were subjected to extensive EMI, RFI and environmental tests. In addition, one of the two units was installed in the Trans World Airlines Concourse, National Airport; qualified, calibrated and approved by the FAA to screen airline



SENTRIE

MILITARIZED WEAPONS DETECTOR

Figure 1



13-1/4
4-1/2
16
SENTRIE WALK THROUGH WEAPON DETECTOR
SIGNAL PROCESSOR SERIAL NO. 1703-1
MERADCOM CONTRACT NO. DAAG53-76-C-0032
INTEX INC CHEVY CHASE, MD
STANDBY POWER ON
A/C POWER ON
BATTERY CHARGING
WEAPON
ALARM
TAMPER LAMP TEST PUSH
INDICATOR LIGHT
FACE PANEL 1703-04
SIGNAL CABLE
STANDBY POWER INPUT
A/C POWER
CONNECTOR
ALARM VOLUME
ALARM CONTACTS
FUSE 3AG 3AMP
SENSITIVITY
A/C POWER PUSH
CARRYING HANDLE
1703-08
RELIEF VALVE
HIGH SECURITY LOCK
AUDIBLE ALARM
1703-013
FACE PANEL HINGE 1703-012
1703-14
FACE PANEL SUPPORT 1703-15
1703-07
CABLE STORAGE
EMI SUPPRESSION FILTER
1703-08
STORAGE CO
RELEAS

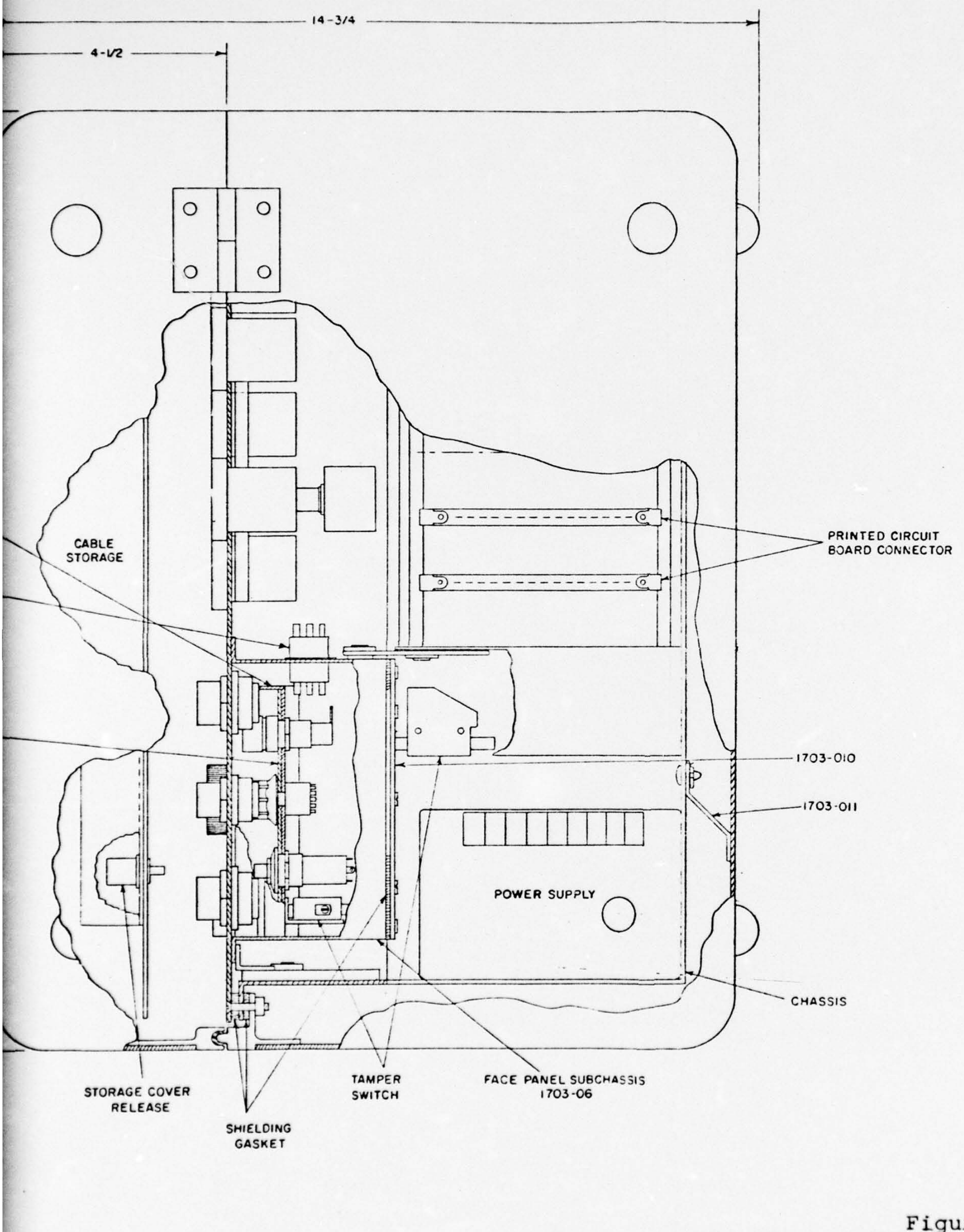
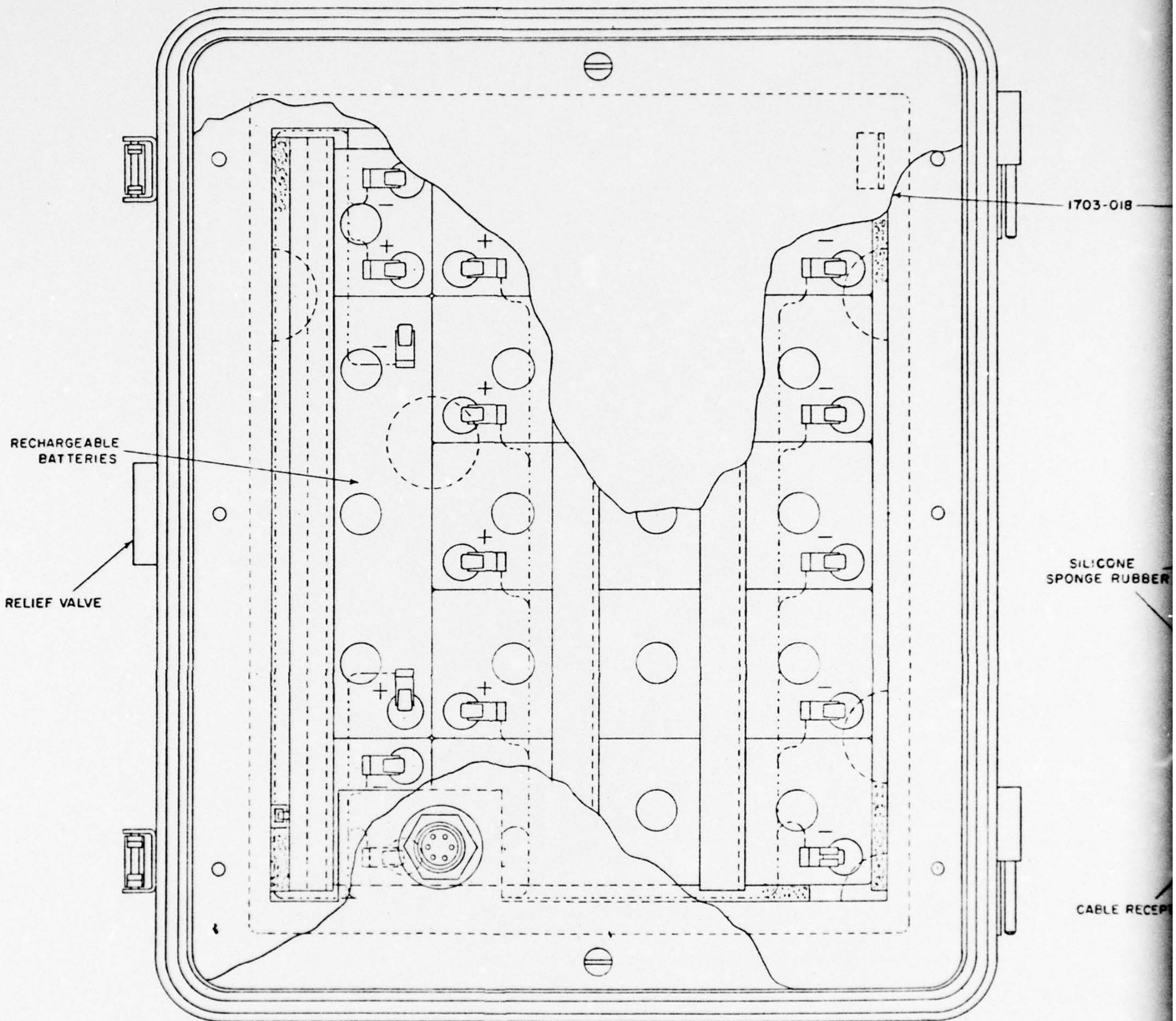
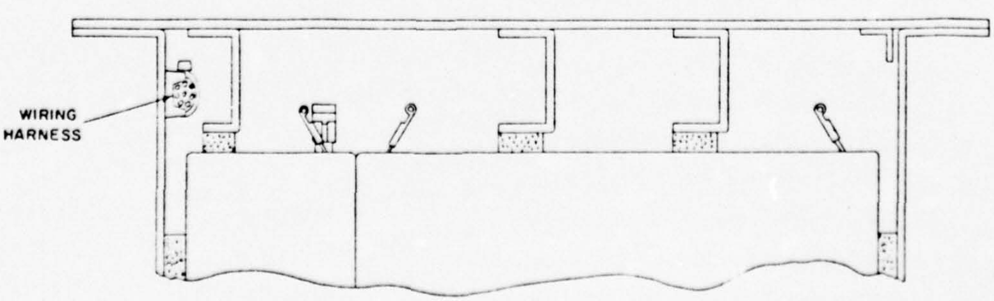


Figure 2

UNLESS OTHERWISE SPECIFIED	APPROVAL	BY	DATE	INTEX Inc. Chevy Chase Md. 20015
DIMENSIONS ARE IN INCHES	DRAWN	SMC	7/14/76	
TOLERANCES: ANGLES ± (FRACTION ±) 2 PLACE DECIMALS ± 3 PLACE DECIMALS ± SURFACE ROUGHNESS	CHECKED			TITLE SENTRIE™ METAL DETECT. SYSTEM
	ENGRG			SIGNAL PROCESSOR ASSEMBLY
	PROJ ENGRG			
	APPROVED FOR INTEX INC			
MATERIAL:	NAME		DATE 19	PROJECT NO 1703 · SIZE D · 1703-01 · REV. 0
WEIGHT: 39 lbs	MODEL NO.			
QTY REQD	DO NOT SCALE DRAWING			SCALE 3/4 · SHEET



1703-018
RECHARGEABLE BATTERIES
RELIEF VALVE
SILICONE SPONGE RUBBER
CABLE RECEPT



WIRING HARNESS

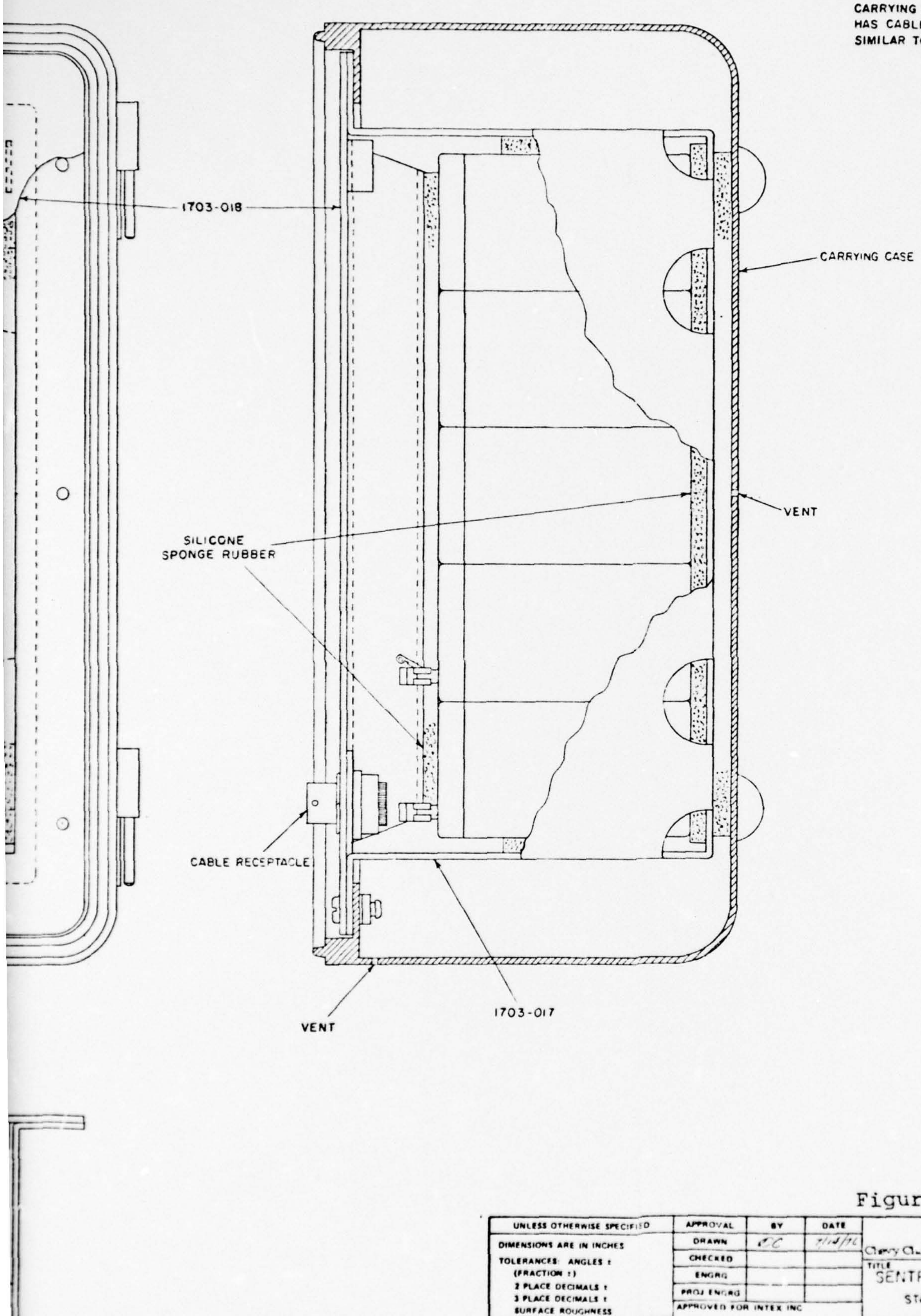
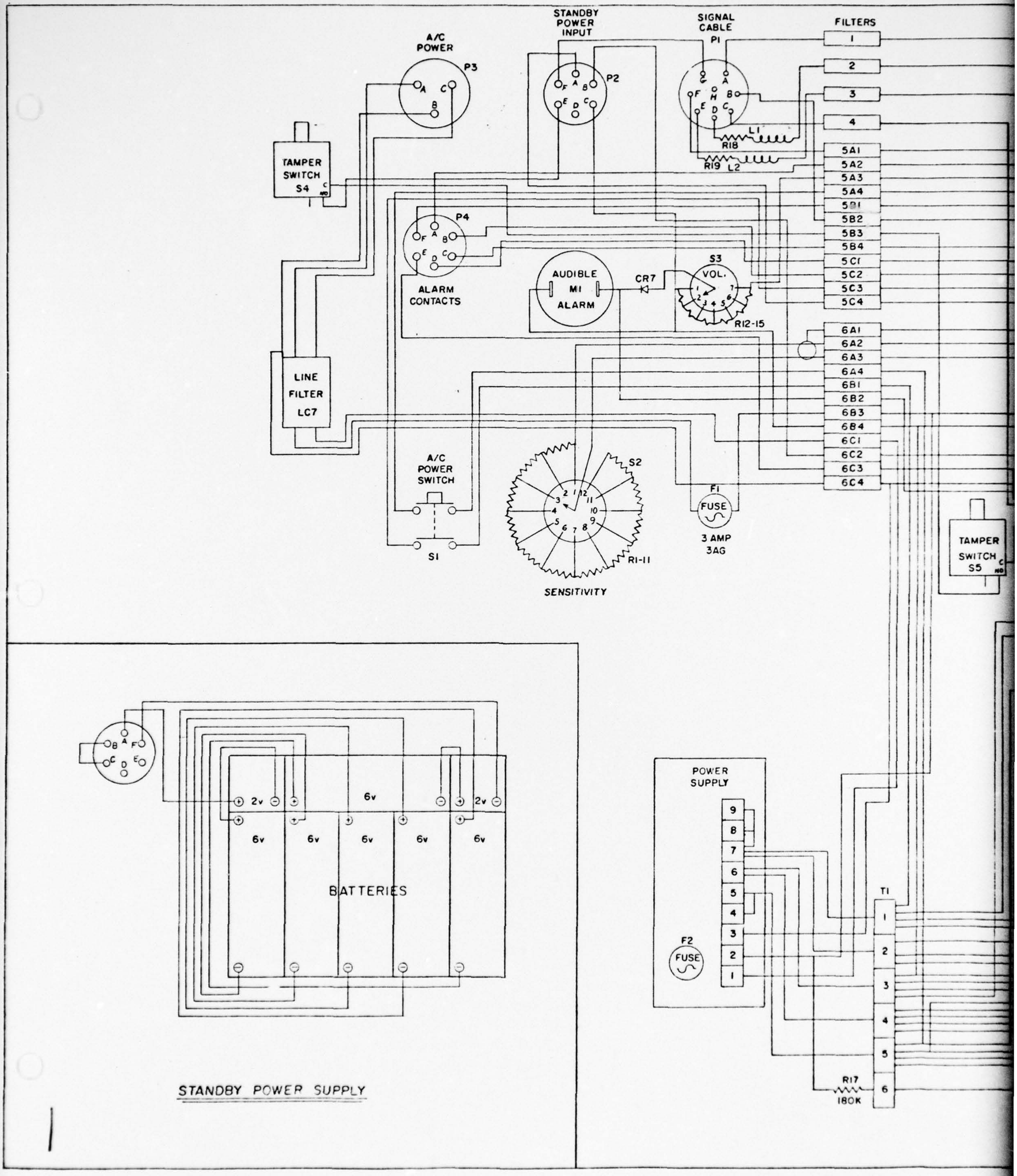


Figure 3

UNLESS OTHERWISE SPECIFIED	APPROVAL	BY	DATE	INTEX Inc. Chevy Chase Md 20015
DIMENSIONS ARE IN INCHES	DRAWN	CC	7/14/76	
TOLERANCES: ANGLES ± (FRACTION ±) 2 PLACE DECIMALS ± 3 PLACE DECIMALS ± SURFACE ROUGHNESS	CHECKED			TITLE SENTRIE METAL DETECT. SYSTEM
	ENGRG			STANDBY POWER SUPPLY ASSEMBLY
	PROJ ENGRG			
	APPROVED FOR INTEX INC			
MATERIAL:	NAME		DATE 19	PROJECT NO. 1703 · SIZE D · 1703-02 · REV 0
WEIGHT: 40 lbs	MODEL NO.			
QTY REQD: 1	DO NOT SCALE DRAWING			SCALE FULL · SHEET



A/C POWER
P3
STANDBY POWER INPUT
P2
SIGNAL CABLE
P1
FILTERS
1
2
3
4
5A1
5A2
5A3
5A4
5B1
5B2
5B3
5B4
5C1
5C2
5C3
5C4
6A1
6A2
6A3
6A4
6B1
6B2
6B3
6B4
6C1
6C2
6C3
6C4
L1
R18
R19 L2
TAMPER SWITCH S4
P4
ALARM CONTACTS
AUDIBLE M1 ALARM
CR7
S3
VOL.
R12-15
LINE FILTER LC7
A/C POWER SWITCH
S1
S2
R1-11
SENSITIVITY
F1
FUSE
3 AMP 3AG
TAMPER SWITCH S5
2v
6v
BATTERIES
POWER SUPPLY
F2
FUSE
T1
R17
180K
STANDBY POWER SUPPLY

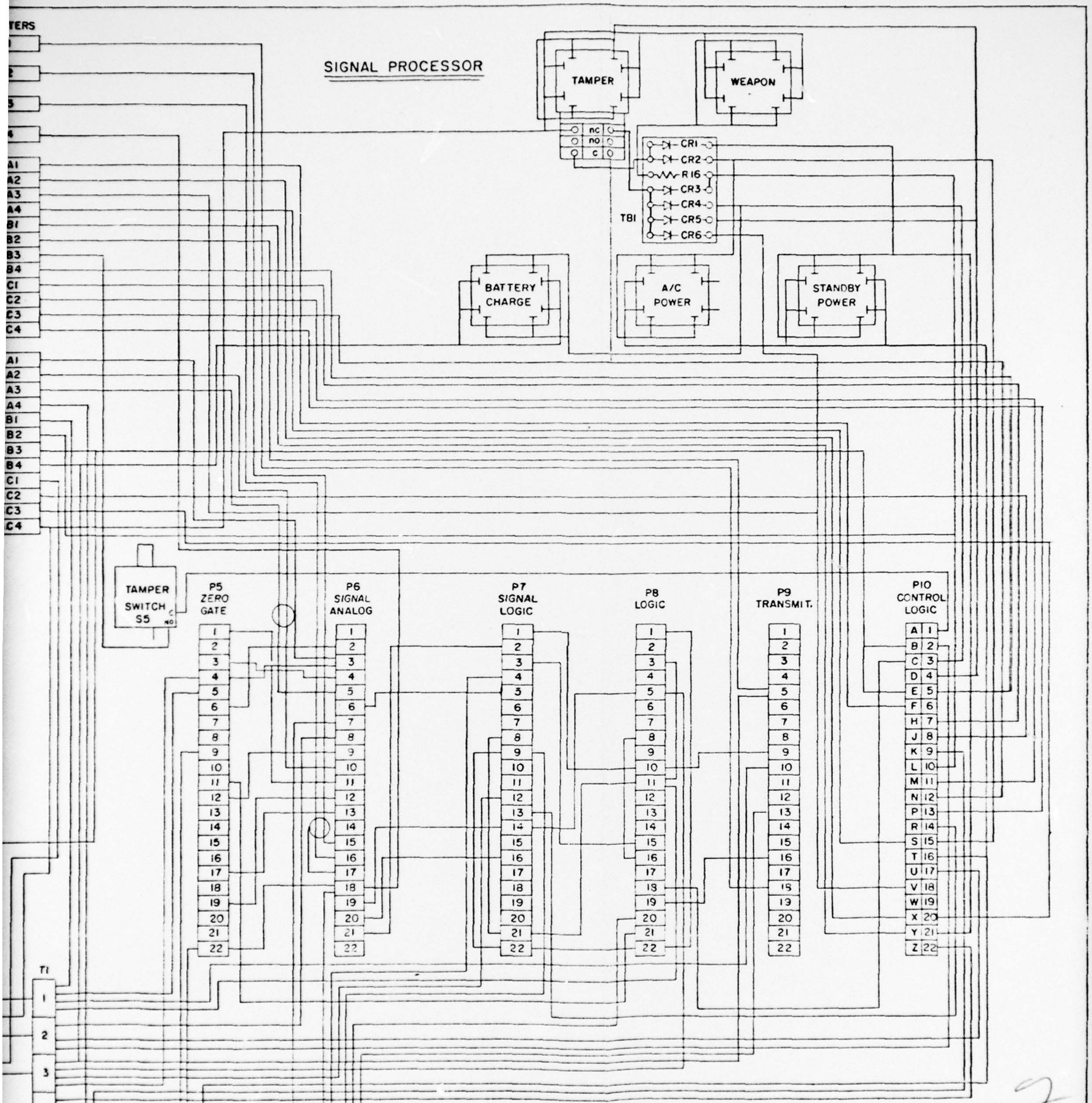


Figure 4

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES: ANGLES ±
(FRACTION ±)
2 PLACE DECIMALS ±
3 PLACE DECIMALS ±
SURFACE ROUGHNESS
MATERIAL:
WEIGHT:
QTY REQD:

APPROVAL	BY	DATE
DRAWN	RJC	1/29/77
CHECKED		
ENGRG		
PROJ ENGRG		

APPROVED FOR INTEX INC
NAME DATE 19
MODEL NO
DO NOT SCALE DRAWING

INTEX Inc.
Chevy Chase Md. 20015
TITLE
SENTRIE METAL DETECT. SYSTEM
WIRING DIAGRAM

PROJECT NO.	SIZE		REV.
1703	D	1703-019	0

SCALE: SHEET

passengers and run continuously for one month as the sole weapons detector on that concourse.

These detectors passed all testing with one minor exception which was deemed unimportant. They proved very stable in operation, immune to external disturbances, and very insensitive to baggage handling and other activities external to but in proximity to the units. Airlines security personnel commented favorably on the convenience and improved performance features of the equipment during the airport trials.

III.0 THE PROGRAM

The development program required major effort in four areas: 1) circuit design to meet control and peripheral functions required of the militarized unit, 2) filtering, EMI, RFI and Faraday shielding to meet contract and performance specifications, 3) filter, shielding, container, and electrical interface design to mesh all functions together, and 4) reliability study of the then-existing design and determination of component types needed in militarized version to meet contract reliability levels.

As the program developed, bench testing and calculations of the various requirements elicited the need to provide more extensive enclosure shielding of the instrument housing than had been initially anticipated. This had a significant impact on the program because extensive mechanical design effort was needed to develop the enclosure peripherals for easy access and maintainability although the actual amount of additional shielding was not that great.

The other area that required unexpected additional effort involved Faraday shielding of the receiver coils. Several different electrically satisfactory designs were assembled and tested, but for a variety of reasons were not deemed suitable in light of the fact that these coils would be subject to severe mechanical and humidity stressing. A design was finally evolved that proved satisfactory for this application.

As a result of time slippage while resolving these two technical areas and simultaneous performance improvements being achieved in the commercial equipment; INTEX in mutual agreement with COTR decided to incorporate a number of improvements into the militarized units at no additional cost to the Government. This action was taken because it became clear that the improvements would enhance performance and reliability helping to insure success during the testing phases.

During the program it was required to demonstrate a system MTBF greater than 10,000 hours. An initial evaluation of the cost of conversion to all Mil Spec components indicated exhorbitant cost and delivery delay. As a result, the manufacturers of the system components were individually reached and actual production reliability figures obtained for every component in the system. It was found that 1) If all potentiometers were eliminated from the system, 2) certain capacitors replaced with hermetic equivalents, 3) all integrated circuits in Ceramic Packages, 4) the wattage ratings of several zener diodes increased and 5) the circuit improvements being incorporated in the commercial equipment implemented; a 12,00 hour MTBF would be achieved.

All reliability calculations and analyses were made in accordance with Mil Handbook 217. Calculations were based upon component data as provided by the original manufacturers. A detailed report on the reliability calculations and analyses was presented by INTEX as document A008, "Reliability Calculations and Military Specification Parts Lists" submitted during the early phase of the contract.

The walk-thru archway in the commercial version is a laminated Formica structure fabricated in the same manner as other Formica covered commercial items. An investigation of the glues and encapsulating resins used in the commercial unit showed that they were unsatisfactory over wide temperature and humidity ranges. As a result, proper materials were obtained, test samples fabricated and a full temperature humidity environmental test run on samples before actual archway construction began since a design failure in this item would prove very costly and wasteful. The actual archway, after test, showed no evidence of warping or delamination even though it was fabricated in straightforward fashion using only wide range glues and encapsulatants in deviation from commercial practice.

IV.0 TEST RESULTS

The final system was tested under three classes of tests; functional/operational tests, environmental tests, and electromagnetic susceptability tests. Functional tests were performed on the basis of a test plan prepared in conjunction with the COTR early in the contract, and conducted by representatives of the COTR and the Contractor. All other tests were conducted by independant outside laboratories.

The functional tests indicated that the system met the functional and operational requirements of the original Purchase Description with some question concerning exact performance with respect to detection

rate and false alarms. However, as stated in this report, since delivering the military adapted commercial device, the existing commercial unit has performance characteristics far in excess of those required by the original Purchase Description.

Results of the environmental and electromagnetic susceptibility tests proved satisfactory in that the system met the requirements of the Purchase Description. One minor problem was noted in the electromagnetic susceptibility test in that the system proved susceptable at 2.45Mhz and 3.2V/m. This defect was considered to be of little or no consequence with respect to the performance of the unit in its anticipated operational mode. Although correctional filters could be installed to compensate for this small susceptibility, the COTR and the Contractor jointly concluded that this was not worth the additional effort. Reports from the outside testing labs on both sets of tests are presented in Appendices III and IV.

Complete details of all tests and results were presented by INTEX in Report No. 1703-3 (Data Item A004), "Test and Demonstration Report" submitted under separate cover. The test and demonstration report contains complete details of the test procedures involved and original data obtained.

After the major part of the work on the system was completed, the major changes such as RFI filters and Faraday shield were retrofit into a commercial unit which was then taken to an airport and tested to ascertain the possibility of any unforseen performance degradation and also to examine for performance improvements since airports are electromagnetically noisy environments in general. Satisfactory results were obtained and final construction of the militarized units was continued.

V.0 SUBSEQUENT RESULTS

Because the development effort led to a number of innovations in the system design it became of interest to determine in depth the actual performance of the militarized unit on high throughput applications. As a result, the original contract test plan was replaced by mutual agreement and development in conjunction with COTR with a test program that included many more requirements and aspects.

These additional items were primarily carried out during the airport testing and elicited the strong points and areas that might be pursued in further development work.

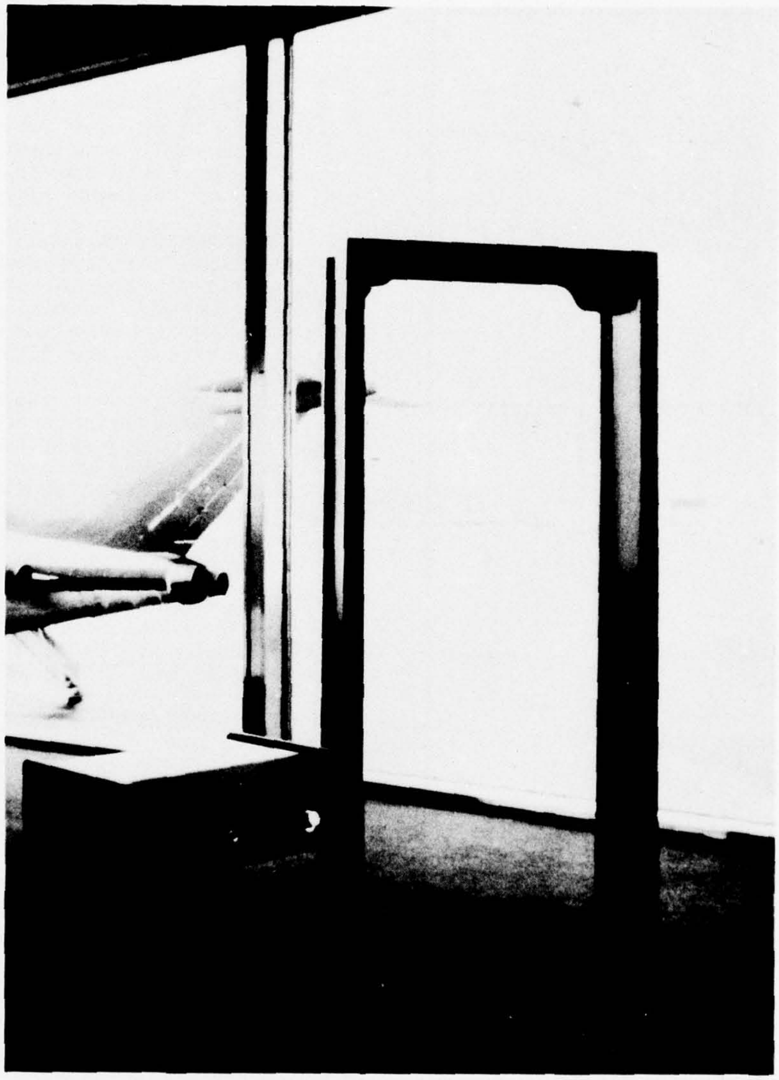
As mentioned previously, the unit was found to be very insensitive to outside interference of all practical types. In addition, because of the narrow archway it was very useful at high throughput rates because a person alarming the unit could readily be identified in the "packed" passenger stream. Subsequent tests by airline personnel on the INTEX Commercial Unit indicated a 4X improvement over other commercially available units in this regard. As a side note; A number of months after the militarized equipment was completed, a breakthrough was made in the false alarm performance of the commercial unit. Tests at several airports show such a low false alarm rate at very high throughputs that it is possible to replace two present detectors with one new one and use one less security guard also. This new development can be retrofit into the militarized units already delivered by replacing three of the plug-in circuit boards if it becomes of interest to MERADCOM to do so.

APPENDIX I

DESCRIPTION OF COMMERCIAL ITEM

SENTRIE™

METAL DETECTION SYSTEM



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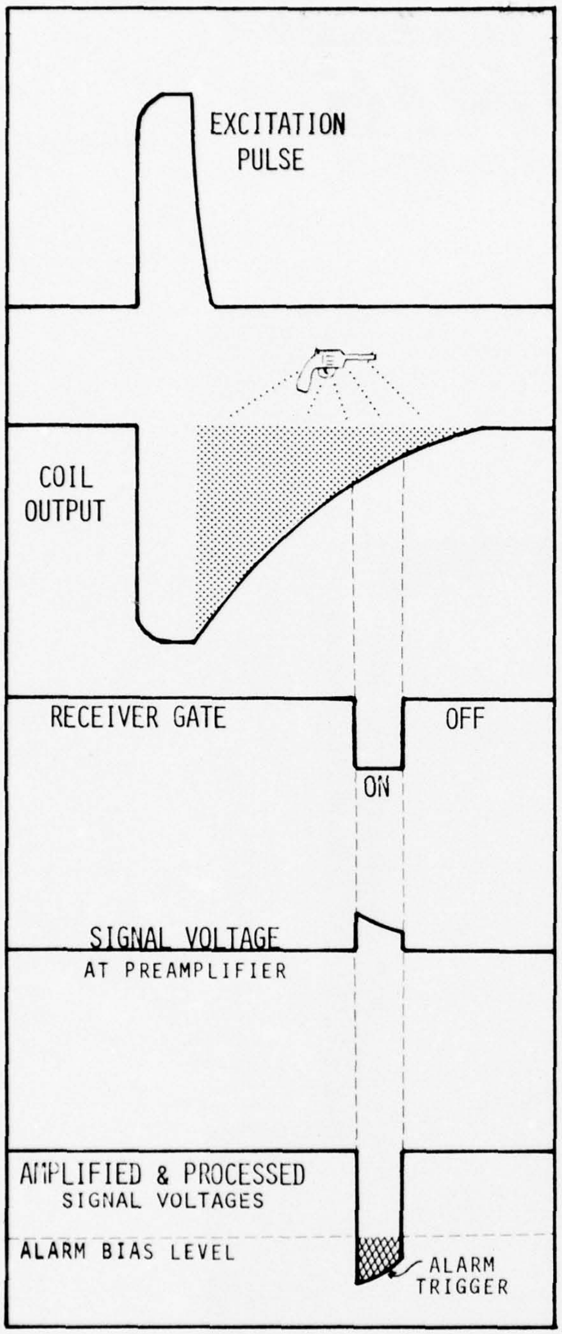


SIMPLIFIED TIMING CHART

SYSTEM DESCRIPTION

Requirements for detection of progressively smaller metal objects at greater relative speeds have pushed last-generation CW technologies toward their limit. Recent use of narrow-pulse excitation of transient eddy-current fields in security applications has taken the art a large step forward with the introduction of SENTRIE Systems in 1975.

This proprietary "Pulsed Field" technology accomplishes the automatic analysis of the pulse-induced eddy-current effects and the use of digital processing techniques for the discrimination of metallic objects in a shaped detection field.

The rapid acceptance of SENTRIE Systems by many Federal, State and Foreign Government agencies and private industry, as evidenced by an impressive and rapidly growing users' list, is probably due to certain unique advantages of this new-generation technology.

° It permits comparison of eddy-current decay times. As different metals exhibit unique decay characteristics, the time-rate of decay becomes an additional parameter in identifying the type and mass of a metal target object in the detection field.

°° Since decay-time integrals are used as a basis for detection and alarm, rather than the absolute amplitude of induced signal voltages, the system is far less sensitive to fixed metal in its vicinity; therefore it does not need any special balancing adjustments to compensate for changes in its magnetic environment.

°°° Series-opposed sensor coil windings form zones in which electromagnetic interference effects are cancelled. This eliminates a common source of false or spurious alarms.

In the simplified waveform timing chart on the left, one of the bipolar transmitter excitation pulses is shown at the top. On the next line, the combined voltages induced by the primary excitation pulse and the secondary eddy-current decay signals are shown as they appear at the output of one detection coil; as these coils are paired in polar opposition, the excitation voltage would be cancelled at the receiver input.

The receiver is gated off during the excitation pulse, and turned on shortly thereafter for a few microseconds to sample the secondary signals. The "on" gate is shown, and below it the signal as it appears in the receiver preamplifier stage.

The bottom waveform represents the amplified signal voltage with reference to the alarm bias level. Amplified signal voltages which exceed this level will cause the alarm circuit to be triggered.

The slope of the secondary signal shown is typical of the steels used in weapons. By changing the timing of the gate, it is possible to select decay-slope characteristics peculiar to other types of metal, and thus take advantage of the discrimination capabilities of the system. The FS-1 is normally optimized to discriminate weapon steel from a larger background of signals from coins, keys, jewelry etc., to minimize false alarms from a normally-dressed population carrying normal amounts of personal items.

LATEST STATE of the ART:

STABILITY - No balancing is required. The system is insensitive to fixed metal objects in its vicinity and can easily be relocated without any special recalibration requirement.

INTERFERENCE FREE - Relatively insensitive to electromagnetic or electrostatic interference causing spurious alarms because of the electromagnetic self-balancing feature of the detector coil zones configuration.

SMALL SIZE - Elimination of field-balancing requirement together with new field shaping techniques provide exceptionally high performance with a substantial weight and size reduction over non-pulsed systems.

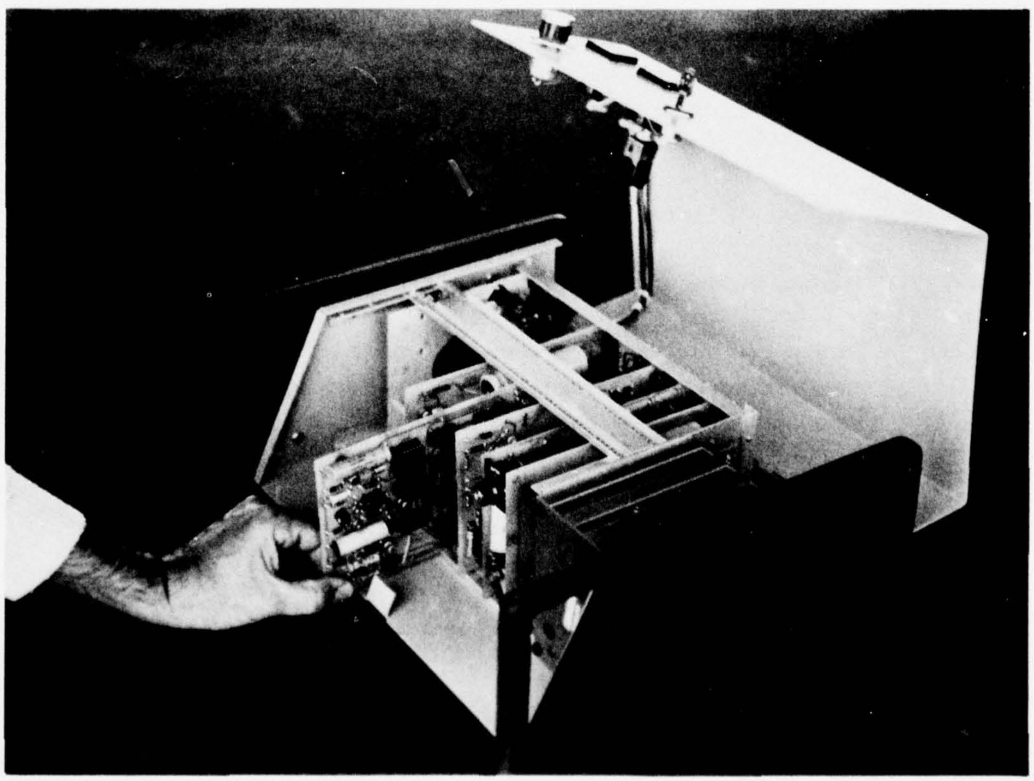
PERFORMANCE - SENTRIE Systems are capable of recognizing differences in the amplitude, polarity and slope ($\dot{\phi}$) of signal returns. As these phenomena relate to relative permeability and conductivity, it becomes possible to differentiate between metals with substantially different magnetic and/or conductive characteristics.

FLEXIBILITY - Sensor coil panels can be constructed with a much smaller cross sectional area than illustrated, so that they can be mounted (or concealed) within existing doorframes. Any dimension of these panels can be changed over a broad range to suit special applications. Double-portal, co-planar, portable and battery-operated versions are also available for screening personnel or non-metallic containers.

NO WALKWAY STRUCTURE - Pulsed-field technology permits shaping of the field to provide uniform detection at ankle level or below, without the nuisance, hazard and added cost of raised walkways.

RELIABILITY - Outstanding reliability of solid-state modular construction is evidenced by over a million hours of operating experience, most of which has been in hostile and high-vibration industrial environments. All electronic components are readily accessible for ease of maintenance, and plug-in printed-circuit boards or μp modules are used for rapid servicing.

ACCEPTANCE - The SENTRIE Model FS-1 meets all the requirements of FAA Security Manual Chapter 5, U.S. Bureau of Standards criteria and NILECJ Standards for Security Levels 1, 2 and 3. It is approved and used by U.S. Federal Judiciary, Legislative, Military, Executive and Criminal Justice agencies, and by major aviation and industrial corporations.



SENTRIE ELECTRONICS CONSOLE

Illustrating the compact modular construction

TECHNICAL SPECIFICATIONS

MODEL FS-1 WEAPONS DETECTOR

OPERATION: Designed to detect <u>any</u> metal by using pulsed magnetic fields to excite transient eddy currents in target metal objects, and to sense and process secondary signals during the on and/or off time of the excitation pulses. Alarm levels shall be adjustable over a broad range, allowing for normal detection of a .22 calibre handgun with a non-ferrous frame or a 2-oz knife with a confidence level of 95% or better.

DISCRIMINATION: The processor is normally programmed to alarm on all metals, but can be programmed for special applications to alarm selectively on certain classes of metals according to customer requirements.

CONSTRUCTION: Sensor coils are encapsulated in ruggedized panels with a formica finish. Console is constructed of heavy-guage aluminum with solid walnut end-panels; key-locking cover is rear-hinged for full access to all circuitry. Circuit controls and assembly screws accessible only from inside of locked cabinet as an anti-tamper measure. One (red) alarm lamp, one (green) standby/normal lamp and an audio volume control for the internal audible alarm unit are located on the sloping front panel of the console.

DIMENSIONS:

		NET	AIRSHIP
Floorspace required	3.5 sq.ft.		
Passageway clearance	13½x30x77"		
Overall arch assembly	13½x36x79½	60 lbs	70 lbs
Electronic Console	12½x17½x6¼	20 lbs	25 lbs
Cubic Feet of system		7½	10

POWER REQUIREMENT: Less than 100VA at 115V or 230V 50/60Hz

ENVIRONMENTAL: -10°C to +55°C up to 95% Relative Humidity

REMOTE ALARM: Customer-furnished remote alarm devices and shielded (pair) cable may be connected for operation up to 200 feet from console. Remote alarm contacts are provided on alarm relay, and accessible at screw terminals in rear of console.

DOCUMENTATION: Installation & Operation Manual and Maintenance Manual.

WARRANTY: One year from acceptance date, in accordance with terms and conditions specified in technical documentation.

July 1976

APPENDIX II

ORIGINAL PROPOSED DESIGN

IV.0 PROPOSED DESIGN

IV.1 General

The proposed design package to meet the requirements of the Solicitation is based upon considering the base starting point to be the unit now under construction by INTEX for airport tests, incorporating latest available coil design information, and packaging the coils, console and battery power supply in commercially available cabinets, cases and structures suitable for the design requirements. The proposed system configuration is shown in Figure 6. This configuration represents a minimum departure from the current system and will satisfy the design requirements. Details of each major sub-system and/or components along with the proposed configuration to meet the design requirements are presented below.

IV. 2 Walk-through Coil System

As shown in Figure 6, the coil system will consist of two identical panels, each 2" x 8" in cross section, 80" overall height, held in place by simple floor supports and two horizontal cross members. One panel will house the transmitter coil of overall dimensions approximately 6" wide and 80"high. The receiver panel will contain the two receiver windings each 5"wide by 80" high.

The receivers will be side-by-side in the same plane connected in series-opposing fashion to achieve the same result of insensitivity to transient external fields as in the case of the original prototype. For detection purposes, however, the signal strength is reduced with no reduction in signal to noise ratio. This reduction in signal is simply compensated for by increasing the gain of the electronic amplifier, in which there is more than ample reserve for weapons detection. This configuration has been operated in the laboratory and it was found that, whereby about 30% of the gain control was used in the original configuration for weapon detection, 75% is required with this configuration. This is a perfectly reasonable mode of operation and provides the advantage of structuring both coil sets in an identical, compact fashion for ease in transportation and assembly.

Each receiver panel slides into a trapezoidal base structure with an opening such as to provide a close, slide fit of each panel. No fasteners are required at the base. The upper portion of the panels are held stationary with respect to each other by two, 2" x 2" cross-

members (wood) each end fitted with a threaded, 1/2" nylon insert. The cross members are fastened with ball-ended knobs having a three inch, 1/3" threaded nylon rod to fit the threaded insert in the cross-member. The transmitter panel contains a jumper cable for connection to the receivers by means of a 3-pin Cannon plug to a corresponding socket on the receiver panel. The transmitter panel also contains an 8-pin Cannon socket for connection of the two sets of signal leads and a pair of tamper tracer wires to the electronic console by means of the cable provided for this purpose.

Assembly of the entire structure requires only the following minimal procedure which could be accomplished in five minutes by one person after the assembly is unpacked:

1. Place both trapezoidal supports on the floor in their approximate final position.

2. Place the transmitter and receiver panels in each support. The panels will stay self-standing while the top cross supports are installed.

3. Install one cross support at a time using the ball-ended threaded rods in one end, then the other.

4. Connect the Cannon-plug from the transmitter cable to the socket on the receiver.

5. Connect the cable from the electronic signal processor to the socket on the lower portion of the transmitter panel.

The panels will be of wood structure, finished in a plain-colored laminate of Formica for the prototype units. Future units could be finished in any non metallic material suitable to meet the requirements of any specific application. When completed, each panel will weigh between 16 and 20 pounds, floor supports approximately 8 pounds each, and cross members and cables less than 5 pounds. The total weight for the complete assembly will be less than 65 pounds.

The final design will be developed in terms of the required environmental and operational specifications per Section 3.4 of the Purchase Description. This will require selection of materials, fasteners, adhesives, and connectors consistent with those specs and the appropriate MIL specs cited in Section 2 of the Purchase Description, especially MIL-STD-454, MIL-STD-461, and MIL-H-46855.

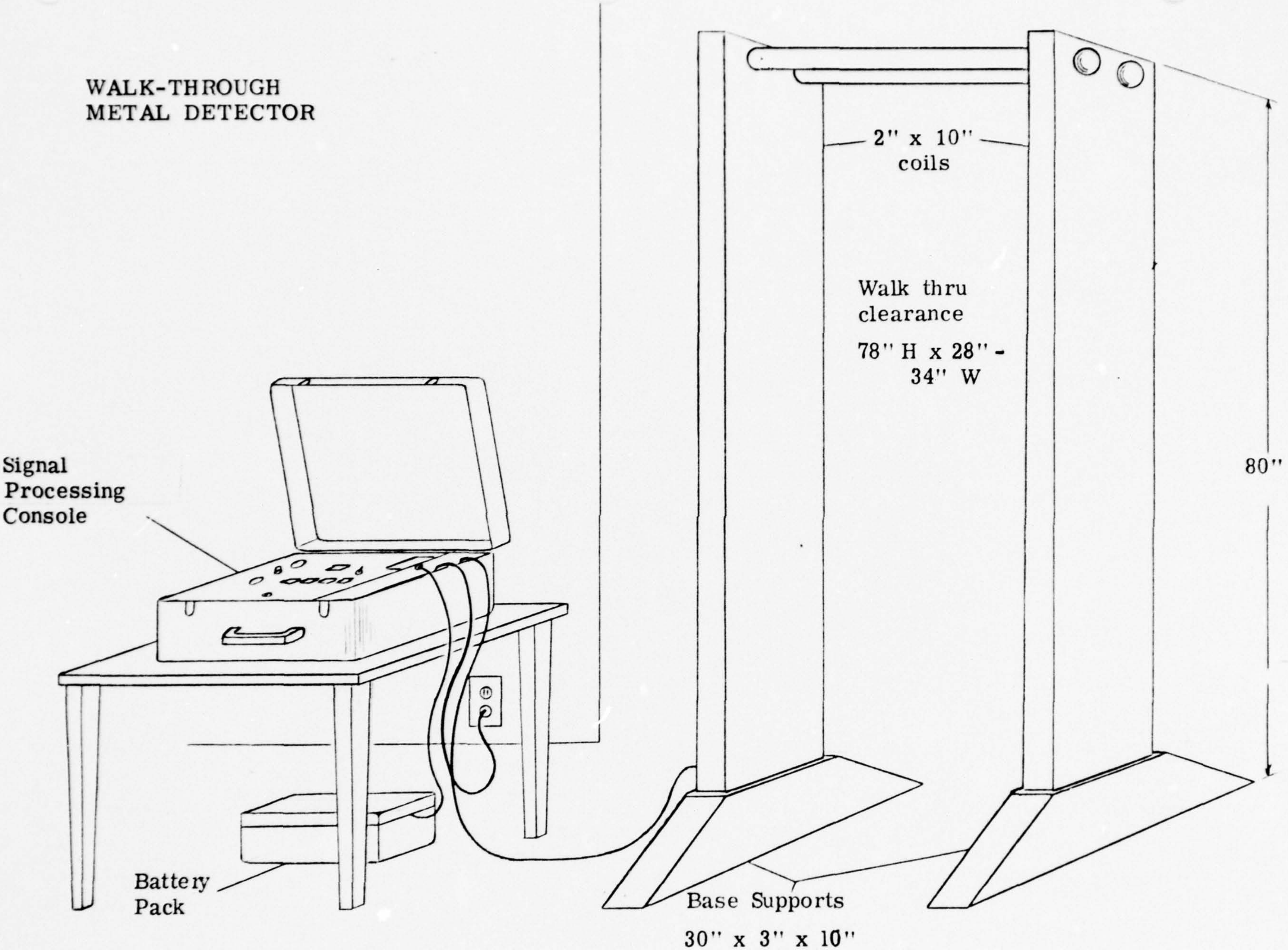


Figure 6. Proposed System Configuration

IV.3 Signal Processing Console

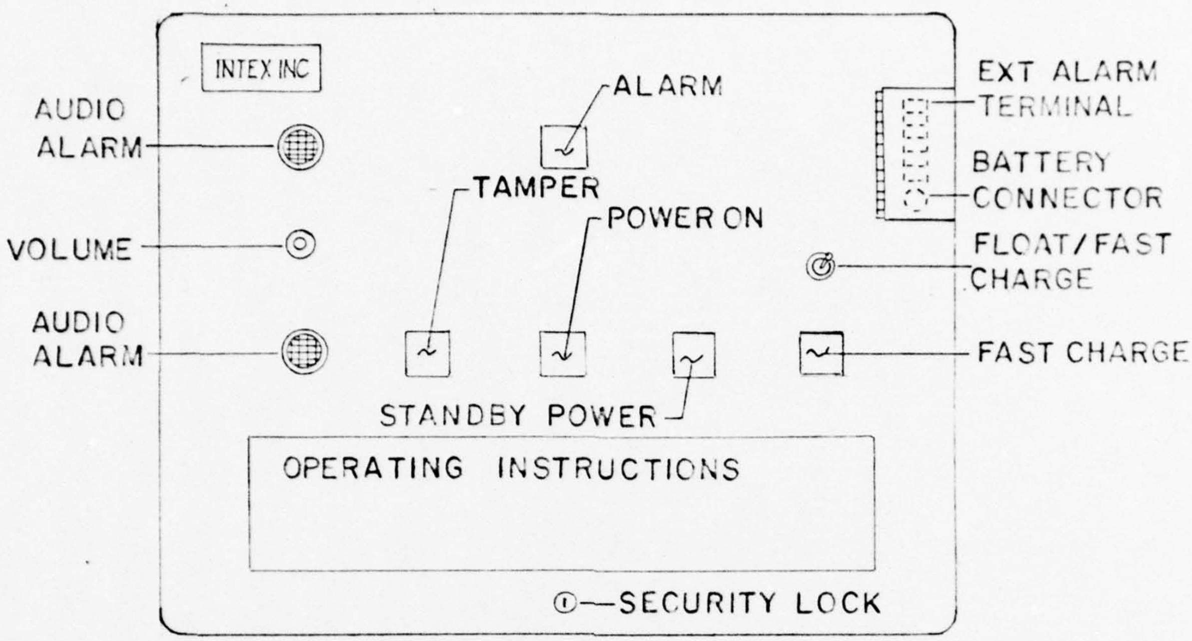
The console will contain that portion of the standard commercial system required for the weapons detector only. This excludes such items as; the Clip Detector circuitry used to sense and nullify alarms which would be due to the clips on conveyor belt assemblies, additional relays for marking and or otherwise controlling the location of the metal within the material being conveyed, and other miscellaneous terminal boards, indicators, etc. primarily used in the industrial applications. The required elements are; card rack containing the five P/C signal processing boards, ±20 VDC power supply, zero gate and signal gate transformors, sensitivity control potentiometer, alarm relay, battery charger, alarm indicating lamps, terminal boards and connectors. All power is furnished from the ± 20 VDC supply with a maximum drain of 0.5 amp from each half.

It is proposed to package the console in an impact-resistant, plastic, standard MIL Spec carrying case as available from sources such as Zero Manufacturing, Inc. The proposed design is illustrated in Figure 7.

The signal processor will contain the elements and components identical to those in the commercial unit assuring that the environmental specifications required in the Solicitation will be met. The only departure from the commercial unit will be the relative re-location of the P/C card rack, transfomers, and sensitivity control knob, and the addition of the alarms required. This could introduce noise problems usually anticipated when such relocation of a known system's components is attempted, but the problem is always solvable by well known techniques for locating such problems and routing wiring and cables to completely eliminate it.

The top panel of the processor will be hinged and locked with a double-action, high-security, lock. A micro switch for tamper protection will be located under the hinged top panel along the front edge at a convenient location between the lock and outer edge of the panel. The cable for connection to the coil assembly and AC power cord will be stored in compartments as shown. A terminal board for access to the relay, alarm contacts (both weapon and tamper) and connector socket for battery power supply are located under a small cover plate in upper right-hand portion of the panel.

When completed, the signal processor, including carrying case will weigh approximately 45 pounds, will be 14" x 18" x 10" high (closed) overall dimensions, and suitable for transportation as a single item



SIGNAL
PROCESSING
CONSOLE

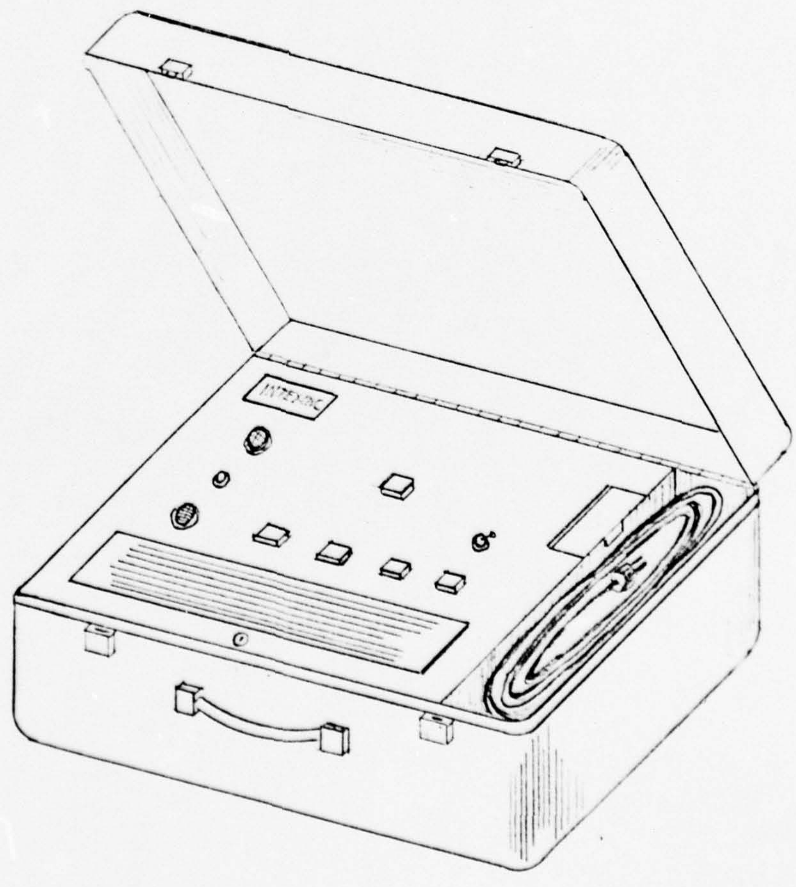


Figure 7. Proposed Signal Processing Console - Portable Walk-through Weapon Detector

or packaged in a container with the coil assembly and Battery Power Supply.

IV.4 Battery Power Supply

The battery power supply will be packaged separately in its own carrying case matched to that of the signal processor as shown in Figure 9. The supply will consist of +20 and -20 volts with respect to a "0" center tap. Each 20-volt section will consist of three, 6-volt cells and one, 2-volt cell each rated 7.5 Ampere-Hours. Since the drain on each 20-volt section will be a maximum of 0.5 amperes, these batteries will suffice for a minimum of 12 hours operation on battery power.

The batteries will be sealed, rechargeable types with gelled electrolytes. Specifically, they will be gel/cell as available from the Globe Battery Division of Globe-Union Inc., Model GC-680-1, 6-volt cells and Model GC-280-1, 2-volt cells. These batteries satisfy the requirements of the Bid Purchase Description with one minor exception as follows; the batteries are rechargeable from 10 to 80% full charge in 12 to 14 hours and not from 10 to 90% in 12 hours as required in the specification. This is a minor departure deemed necessary to insure long battery life by avoiding over-charging conditions. The effect on operational performance, however, from a practical standpoint, is essentially nil.

As shown in Figure 8, the batteries will be packaged in the carrying case having a single cable for direct connection to the signal processor. This will be a 5-conductor cable carrying the ± 20 VDC to the processor and a pair of tamper tracing wires. The Power Supply will have no lights, switches or other controls as those are all located on the front panel of the signal processor. When completed, the battery power supply will weigh less than 30 pounds (including carrying case and cable) and be 8" wide, 14" long, 6" high with storage space for the connecting cable.

IV.5 Electrical Interconnection

The interconnection between the signal processor and walk-through coil assembly will remain identical to the original commercial unit with the exception that a pair of conductors, shorted at the cable coil connector, will be provided as tamper protection and alarm indication for broken or disconnected cable. The power supply, tamper alarms,

BATTERY POWER SUPPLY

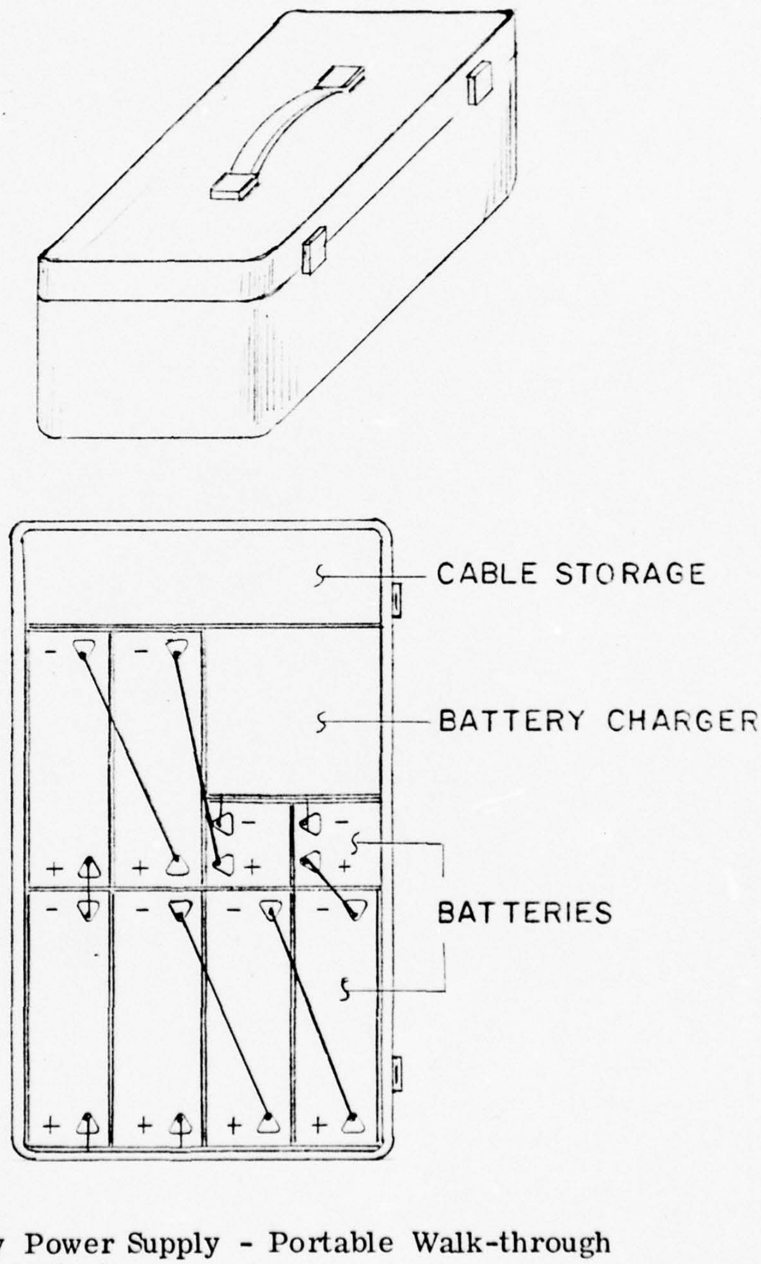


Figure 8. Battery Power Supply - Portable Walk-through Weapon Detector

emergency changeover, and cable-disconnect or break indicators represent additional circuitry to the standard unit.

This additional circuitry is straight forward and will be as shown on the Wiring Diagram, Figure 9. The relay, PS, is activated by the AC power and drops out upon power failure thereby connecting battery power to the console while opening up the output terminals of the system power supply. The relay also energizes the battery power indicator lamp.

The tamper alarm switch is connected in series with the two tracer pairs in each cable. Opening of the switch, breaking or disconnecting either cable drops out relay TA which is held in by closure of those circuits. The tamper lamp and alarm are activated in this event. The tamper alarm (audible) is a warbler type with a sound distinctly different than the weapon alarm which is a straight tone of approximately 0.5-1.0 second duration. Both audible alarms are standard "Sonalert" devices normally used for this purpose.

Normally open relay contacts from the tamper alarm relay, TA, and power relay, PS, are brought out to the terminal board along with normally closed contacts from the weapon alarm relay. This arrangement is in compliance with the Electrical Interface requirements of Paragraph 3.5.13 in the Purchase Description.

IV.6 Packaging, Transportability and Set-up

As defined above, the entire system consists of three units; walk-through coil assembly, signal processor, and battery power supply. The combined weight of all three units will be 140 pounds or less. This beats the requirements of the specification in the Bid Purchase Description of 140 pounds allowable for the CEI exclusive of the battery power supply.

The entire system, with the walk-through coil disassembled will comfortably fit in a space envelop of 80" length, 30" width and 12" depth. This is well below the allowable of 96" x 48" x 8" in the specifications. Since portability is a main requirement for the system, this proposed approach represents a truly portable system in terms of required space, weight and operational conditions.

The shipping container design is a relatively straight forward task, the actual design is left as a task within the program. The design will be in accordance with the required shock limitations and according to specifications PPP-B-636 and PPP-C-843.

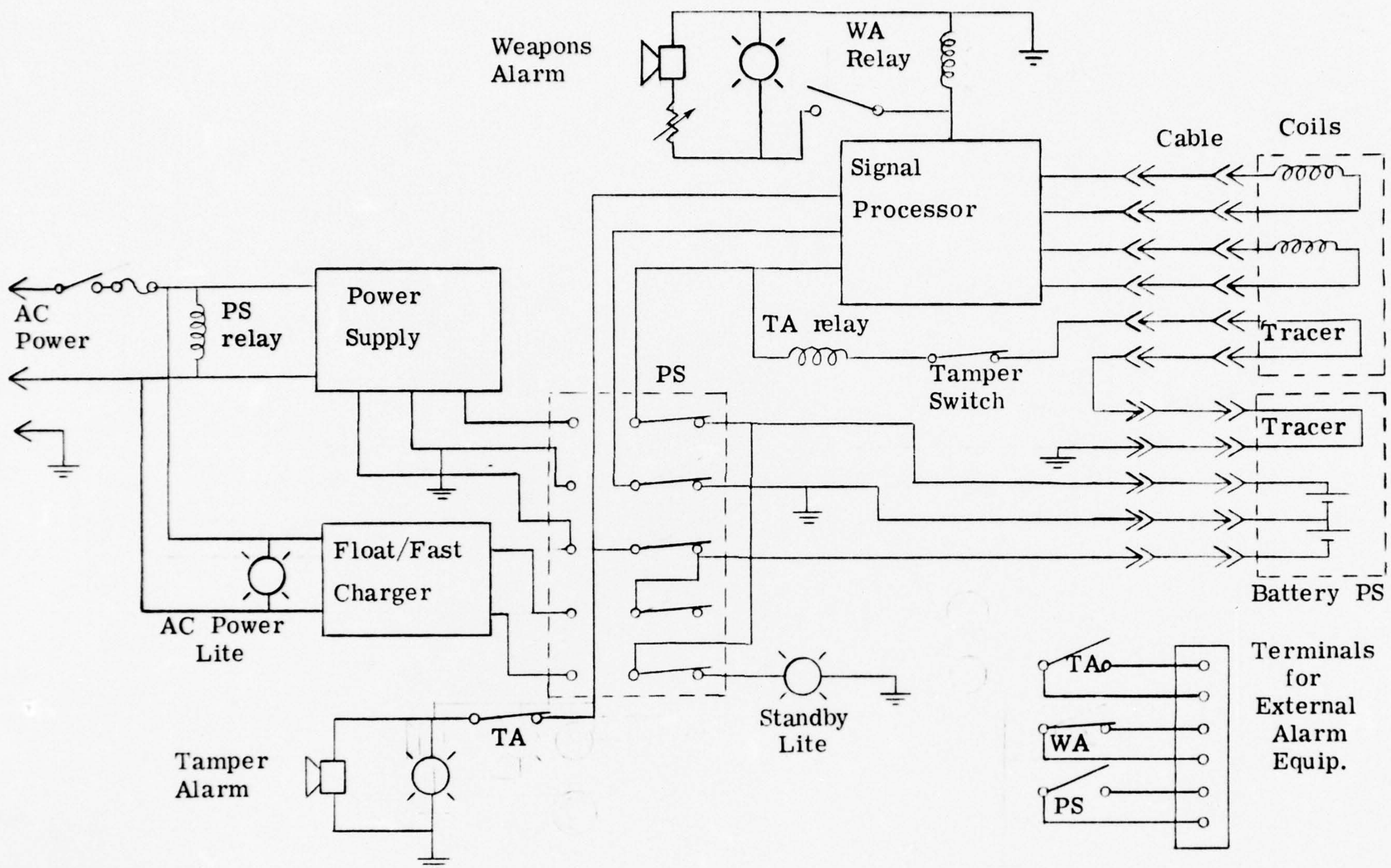


Figure 9. Electrical Wiring Interconnection Diagram

Assembly of the system can be accomplished by one person in less than 15 minutes and probably less than 10 minutes after one assembly experience. The steps involved and estimated times are as follows:

1. open crate or container -- 3 min.

2. remove coil floor supports and set in place -- 2 min.

3. remove and insert vertical coil panels -- 1 min.

4. remove and install two cross supports -- 1 min.each -- 2 min.

5. remove signal processor, open cover, plug in cable to coil -- 2 min.

6. remove battery power supply (if used), open cover, connect cable to processor -- 1 min.

7. plug in AC power cord from signal processor, verify no alarm condition and normal alarm states. Allow 1 minute warm up -- 3-4 min.

8. operate.

IV.7 Required Items, Parts, Supplies

The design is based upon modification and re-packaging the existing commercial version of the system and adding on new coils, battery power supply, electrical interface devices, and miscellaneous connectors, cables, etc. The major items/supplies required to complete each prototype are listed below.

1. Standard commercial signal processor, Model 3301.

2. Batteries. Two sets of 6-volt and 2-volt as described above.

3. Carrying cases, two each system, as described above.

4. Miscellaneous electrical items including: Alarm relays, 2 each unit; indicator lamps, 5 each unit; Sonalert alarm devices, 2 each unit; volume control, 2 each unit.

5. Battery charger, one each system, Globe-Union GRC 482000 or equivalent.

6. Cable, multi-conductor, two types approximately 50-ft. each unit plus one, 20-ft. power cord for each unit.

7. Connectors and Plugs, MIL Spec. Cannon, Burndy, Bendix, or equivalent. Three multi-pin plugs and sockets for each unit.

8. Copper wire, 18 AWG and 24 AWG for transmitter and receiver windings. Total of 5 pounds per unit.

9. Wood, Plastic Laminate, hardware for coil assemblies. Approximately 40 sq. ft. per unit.

10. Miscellaneous aluminum sheet, fasteners, brackets for electronic chassis and control panels. Quantity is minimal but not more than 3 or 4 pounds per unit.

APPENDIX III

ENVIRONMENTAL TESTS

GENERAL

General Environments Corporation / Hartwood, Virginia 22471 / (703) 752-5361

JAN 24 REC'D

REPORT

Client: Intex, Inc.
6935 Wisconsin Avenue
Chevy Chase, Maryland 20015

Report No. A-5257
Date 10 January 1977

Subject: Environmental testing of one Walk-Through, Metal Detector System. Vibration (sinusoidal) in accordance with Mil-Std-810B, Method 514.1, Procedure X, Curves AA and AQ not operating 3000 miles land transportation. Shock in accordance with Mil-Std-810C, Method 516.2, Procedure I, 20 g's and 11 ms terminal peak sawtooth not operating. Humidity in accordance with Mil-Std-810C, Method 507, Procedure I (five cycles only) with operation at the end of each cycle. High Temperature in accordance with Mil-Std-810C, Method 501, Procedure II with operation at 120°F. Low Temperature in accordance with Mil-Std-810C, Method 502, Procedure I with storage at -50°F and operation at 32°F. Testing was completed 23 December 1976.

1.0 VIBRATION (SINUSOIDAL) TEST

Test Facilities

M-B Electronics C-150 Vibration System, GEC No. A164H

Test Procedure

The test items, packaged in shipping containers, were subjected to the vibration schedule presented in Table I in each of the three major orthogonal axes.

TABLE I
Vibration Schedule

Frequency (Hz)	Amplitude
5-10	0.3" d.a.
10-500	1.5 g's pk.

Sweep 5-500-5 Hz in 15 min.
45 min. ea. axis less resonance dwell
ea. 1/6 total time

Test Results

The test items were subjected to the vibration schedule presented in Table I without apparent indication of damage and/or failure as a result of the vibration test exposure. Minor resonances were encountered in the package of electronics equipment in the longitudinal axis and lateral axis at 11 Hz and in the lateral axis at 25.5 Hz.

2.0 SHOCK TEST

Test Facilities

Monterey Research High Impact Shock Machine, GEC No. 140H

Test Procedure

The test items, packaged in shipping containers, were subjected to three shock impacts in each direction of each of the three major orthogonal axes for a total of eighteen shocks. The shock imposed on the test items was a terminal peak sawtooth wave form with a peak acceleration of 20 g's with a time duration of 11 milliseconds.

Test Results

The test items were subjected to the shock test without apparent indication of damage and/or deterioration as a result of the shock test exposure. Following the shock test the test items were unpackaged, set-up and operational tests were conducted by cognizant Intex, Inc. representatives.

3.0 HUMIDITY TEST

Test Facilities

Tenney Engineering Temperature-Humidity Chamber, GEC No. 141D

Test Procedure

The test items, fully assembled, were subjected to five, twenty-four hour cycles of temperature and humidity conditions as presented in Table II. The test item was operationally tested following each of the twenty-four hour cycles by the cognizant Intex, Inc. representative.

TABLE II
Temperature-Humidity Conditions

Temperature (°F)	Relative Humidity (%)	Time Duration (hrs.)
86	uncontrolled	0
86 to 149	95	2
149	95	6
149 to 86	85 min.	16

Repeat above for a total of five cycles

Test Results

The test items were subjected to the five temperature-humidity cycles and operated following each of the five cycles without failure according to the cognizant Intex, Inc. representative. However, following the test exposure the electronics units displayed evidence of paint blistering and corrosion of exposed metal parts.

4.0 HIGH TEMPERATURE TEST

Test Facilities

Tenney Engineering Temperature-Humidity Chamber, GEC No. 141D

Test Procedure

The test items, fully assembled, were subjected to the high temperature test presented in Table III and was operationally tested following the temperature test, while at a temperature of 120°F, by the cognizant Intex, Inc. representative.

TABLE III
High Temperature Conditions

Temperature (°F)	Time Duration (hrs.)
120	6
120 to 160	1
160	4
160 to 120	1

Repeat above for a total of three cycles

Test Results

There was no apparent evidence of failure and/or deterioration of the test items as a result of the high temperature test exposure. The cognizant Intex, Inc. representative operated the test items following the temperature test.

Report No. A-5257
Date 10 January 1977

5.0 LOW TEMPERATURE TEST

Test Facilities

Tenney Engineering Temperature-Humidity Chamber, GEC No. 141D

Test Procedure

The test items, fully assembled, were subjected to the low temperature test presented in Table IV and was operationally tested following the temperature test, while at a temperature of 32°F, by the cognizant Intex, Inc. representative.

TABLE IV
Low Temperature Conditions

Temperature (°F)	Time Duration (hrs.)
-50	48
raise to 32	stabilize

Test Results

There was no apparent evidence of failure and/or deterioration of the test items as a result of the low temperature test exposure. The cognizant Intex, Inc. representative operated the test items following the temperature test.

GENERAL ENVIRONMENTS CORPORATION

APPROVED L. W. Burnett
L. W. Burnett

BY A. A. Ellis
A. A. Ellis

FORM NO. 120

APPENDIX IV

ELECTROMAGNETIC SUSCEPTABILITY TESTS

EMI/EMC TEST EVALUATION REPORT

FOR

SENTRIE WALK THROUGH WEAPON DETECTOR

JANUARY 1977

Prepared for

INTEX, INC.
6935 Wisconsin Avenue
Chevy Chase, Maryland 20015

Under

Purchase Order No. 748-1703-38

Prepared by:

Richard S Kubiak

Richard S. Kubiak
Task Engineer

Approved by:

Robert K. Lyons

Robert K. Lyons
Program Manager

Submitted By:

TEMPEST/EMI Department
Atlantic Research Corporation
Alexandria, Virginia 22314

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1.0 INTRODUCTION

1.1 Scope

A "Sentrie Walk Through Weapon Detector" manufactured by INTEX Inc. was subjected to four EMC susceptibility tests to determine its compliance to the applicable requirements of MIL-STD-461A.

1.2 Conclusions

The Weapon Detector met the requirements of all tests except the Radiated Susceptibility (RS03) test at 2.45 MHz, where it failed by 4 dB. Paragraph 3.4 details the results of the RS03 test.

1.3 Description of EUT

The equipment under test (EUT) was composed of the following items:

a. Signal Processor, S/N 1703-2;

b. Standby Power Supply, S/N 1703-1; and

c. Archway Detector.

1.4 Tests Performed

The EUT was subjected to the following MIL-STD-461A tests:

a. CS01: 30 Hz to 50 kHz

b. CS02: 50 kHz to 400 kHz

c. CS06: 10 μs Spike

d. RS03: 14 kHz to 12.4 GHz

2.0 TEST SETUP

2.1 EUT Setup and Operation

The EUT was installed and tested in a shielded enclosure having inside dimensions of 18L x 10W x 10H ft. The EUT was positioned as shown in Figure 1*and its sensitivity set to a level of "four" on the signal processor unit.

2.2 Test Equipment Setup

The test setups for the four susceptibility tests are shown in Figures 2 through 5. Table 1 lists all test equipment used for this test series.

---

*Figures and Tables are appended.

3.0 TEST RESULTS

3.1 CS01 Test

An interference signal of 3V at a frequency of 30 Hz to 1500 Hz and then diminishing to 1V at 50 kHz was inductively coupled onto the a.c. power lines of the EUT. No malfunctions or false triggering occurred. The test setup for the CS01 test is shown in Figure 2.

3.2 CS02 Test

An interference signal of greater than 1V at a frequency of 50 kHz to 400 kHz was capacitively coupled onto the a.c. power lines of the EUT. No malfunctions or false triggering occurred. Figure 3 shows the test setup for the CS02 test.

3.3 CS06 Test

A 100V pulse, similar in appearance to that shown in Figure 19 of MIL-STD-461, was applied to both a.c. power lines (hot and neutral) of the weapon detector. The pulse was applied for 10 minutes at a rate of 6 pulses per second (pps) on each power line. Pulse polarity was reversed and its phase shifted over the entire 360° of the a.c. lines. No malfunctions or false triggering were detected. Figure 4 shows the test setup for the CS06 test.

3.4 RS03 Test

The EUT was subjected to RF fields of greater than 5V/m from 14 kHz to 500 MHz and greater than 1V/m from 500 MHz to 12.4 GHz. Figure 5 shows the test setup for the RS03 tests. Table 2 lists the instrumentation.

The EUT was found to be susceptible at the frequencies and field intensities listed in Table 3. With the exception of the malfunction at 2.45 MHz, where the EUT was susceptible to a field of 3.2V/m, all malfunctions occurred when the field generated was above that required by the applicable specification.

4.0 RS03 RETEST

Because of the failure of the weapon detector to comply with the RS03 test limit at 2.45 MHz, the test was repeated at 2.45 MHz using a modified signal processor.

The weapon detector, configured with Signal Processor S/N 1703-1, went into an alarm mode when subjected to an electric field of 3.98V at 2.45 MHz. It can be seen that there is no significant difference in the susceptibility threshold of the system using either signal processor.

Table 1. Instrumentation List

ITEM	MANUFACTURER	MODEL NO.	SERIAL NO.	CAL. DATE MO/DAY/YR
SIGNAL GENERATORS				
30 Hz - 10 MHz	Hewlett-Packard	651B	034143	8/8/76
50 kHz - 65 MHz	Hewlett-Packard	606A	033174	8/8/76
65 MHz - 480 MHz	Hewlett-Packard	608E	036844	12/14/76
500 kHz - 1.2 GHz	Hewlett-Packard	8640B	039039	11/1/76
1 GHz - 2 GHz	Hewlett-Packard	614	035430	10/19/76
2 GHz - 4 GHz	Hewlett-Packard	616B	033216	10/19/76
4 GHz - 7 GHz	Hewlett-Packard	618	9215	12/1/76
7 GHz - 11 GHz	Hewlett-Packard	620	035108	10/19/76
11 GHz - 12.4 GHz	Hewlett-Packard	626	035420	10/27/76
AMPLIFIERS				
30 Hz - 100 kHz	McIntosh	MC-60	033295	CNR*
50 kHz - 200 MHz	Instruments for Industry	5000	L/V084	CNR
200 MHz - 500 MHz	Hewlett-Packard	230	4467	CNR
500 MHz - 1 GHz	Microdot	M445/ M187	13093/ 13100	CNR
1 GHz - 2 GHz	Hughes	1177H	034098	CNR
2 GHz - 4 GHz	Hewlett-Packard	491C	9450	CNR
4 GHz - 8 GHz	Hewlett-Packard	493A	11212	CNR
8 GHz - 12 GHz	Hewlett-Packard	495A	9187	CNR
TRANSMIT ANTENNAS				
14 kHz - 30 MHz	Atlantic Research	Panel	-	CNR
30 MHz - 200 MHz	Raytheon	1150-1014	-	CNR
200 MHz - 1 GHz	Electro-Mechanics Co.	3101	041818	CNR
1 GHz - 12.4 GHz	American Electronics Laboratories	ARN-101	432	CNR

*Calibration Not Required

Table 1. Instrumentation List (cont.)

ITEM	MANUFACTURER	MODEL NO.	SERIAL NO.	CAL. DATE MO/DAY/YR
CALIBRATION ANTENNAS				
14 kHz - 150 kHz	Singer-Metrics	VR-1-105	040560	CNR*
150 kHz - 30 MHz	Singer-Metrics	VA-105	210	CNR
30 MHz - 200 MHz	Honeywell	7825	034144	CNR
200 MHz - 1 GHz	Electro-Mechanics Co.	3101	042059	CNR
1 GHz - 12.4 GHz	American Electronics Laboratories	ARN-101	264	CNR
CALIBRATION RECEIVERS				
30 Hz - 50 kHz	Fairchild	EMC-10	034101	8/20/76
14 kHz - 1 GHz (Main Frame)	Singer-Metrics	BA/NF-105	87130	9/7/76
14 kHz - 150 kHz	Singer-Metrics	TX/NF-105	2297	9/7/76
150 kHz - 30 MHz	Singer-Metrics	TA/NF-105	033201	9/7/76
30 MHz - 200 MHz	Singer-Metrics	T1/NF-105	87132	9/7/76
200 MHz - 400 MHz	Singer-Metrics	T2/NF-105	033202	9/7/76
400 MHz - 1 GHz	Singer-Metrics	T3/NF-105	87134	9/7/76
1 GHz - 4 GHz	Watkins-Johnson	MTF-100A (P/O RS-125)	039016	11/16/76
4 GHz - 12.4 GHz	Watkins-Johnson	MTF-101 (P/O RS-125)	039019	11/16/76
MISCELLANEOUS				
Demodulator	Watkins-Johnson	DM-212A (P/O RS-125)	039023	CNR
Transient Generator	Solar	6254-5S	L/V082	8/20/76
10 μF Feedthrough Capacitor	Solar	6512-106R	-	CNR
Oscilloscope	Tektronix	541A	034560	11/9/76
Oscilloscope Vertical Amplifier	Tektronix	CA	L/V047	11/9/76
Power Meter	Hewlett-Packard	432A	039071	8/30/76

*Calibration Not Required

Table 1. Instrumentation List (cont.)

ITEM	MANUFACTURER	MODEL NO.	SERIAL NO.	CAL. DATE MO/DAY/YR
MISCELLANEOUS (cont.)				
Thermistor Mount	Hewlett-Packard	478A	7512	11/3/76
Adapter (Microwave)	Hewlett-Packard	MX292B	-	CNR*
Adapter (Microwave)	Hewlett-Packard	X281A	-	CNR
Directional Coupler	Narda	3022	033313	11/29/76
Voltmeter	Hewlett-Packard	3400A	039055	9/1/76
Voltmeter	Hewlett-Packard	411	033215	9/1/76

*Calibration Not Required

Table 2. RS03 Test Instrumentation

FREQ. RANGE (Hz)	TRANSMIT ANTENNA	TRANSMIT AMPLIFIER	TRANSMIT OR CALIBRATE SIGNAL GENERATOR	CALIBRATE ANTENNA	CALIBRATE RECEIVER
14k - 150k	4'x10' Panel	McIntosh MC-60	HP 651B	Singer VR-1-105	Singer TX/NF-105
150k - 30M	4'x10' Panel	IFI 5000	HP 606/HP 8640B	Singer VA-105	Singer TA/NF-105
30M - 200M	Honeywell 7825	IFI 5000	HP 608/HP 8640B	Honeywell 7825	Singer T1/NF-105
200M - 500M	EMCO 3101	HP 230	HP 608/HP 8640B	EMCO 3101	Singer T2,3/NF-105
500M - 1G	EMCO 3101	Microdot 445/ M187	HP 8640B	EMCO 3101	Singer T3/NF-105
1G - 2G	AEL APN101A	Hughes 1177H	HP 614	AEL APN101A	W-J RS-125
2G - 4G	AEL APN101A	HP 491C	HP 616	AEL APN101A	W-J RS-125
4G - 7G	AEL APN101A	HP 493A	HP 618	AEL APN101A	W-J RS-125
7G - 8G	AEL APN101A	HP 493A	HP 620	AEL APN101A	W-J RS-125
8G - 11G	AEL APN101A	HP 495A	HP 620	AEL APN101A	W-J RS-125
11G - 12.4G	AEL APN101A	HP 495A	HP 626	AEL APN101A	W-J RS-125

Table 3. Weapon Detector Susceptible Frequencies

FREQUENCY, MHz	SUSCEPTIBILITY THRESHOLD, V/m	MIL-STD-461A FIELD, V/m	EUT vs. MIL-STD-461A in dB
0.5	6.3	5	+2
0.85	8.9	5	+5
2.45	3.2	5	-4
2.9	17.8	5	+11
4.45	26.6	5	+14.5
4.65	23.7	5	+13.5
6.7	19.5	5	+12
19.75	8.4	5	+4.5
420.	6.7	5	+2.5
425.	7.9	5	+4
490.	7.3	5	+3
710.	26.4	1	+28.5
835.	14.1	1	+23
890.	8.5	1	+18.5

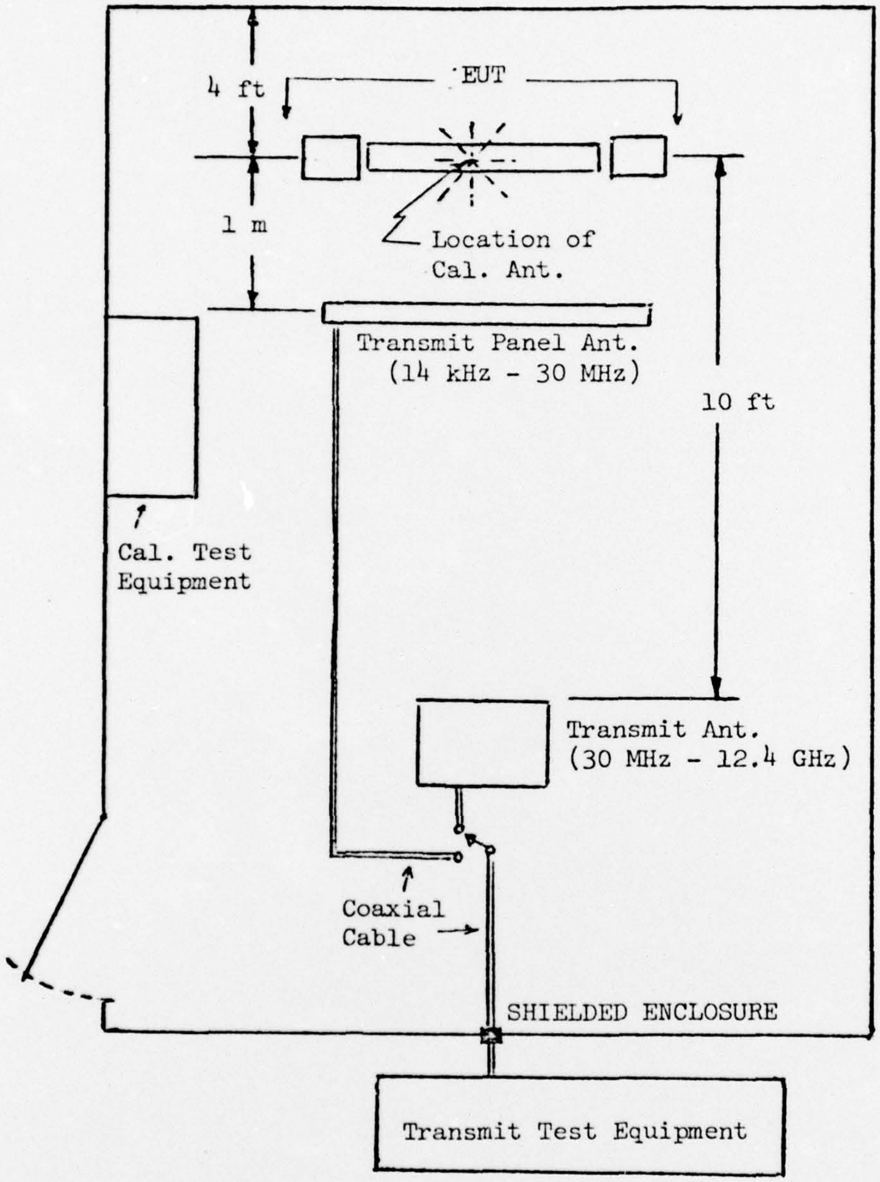
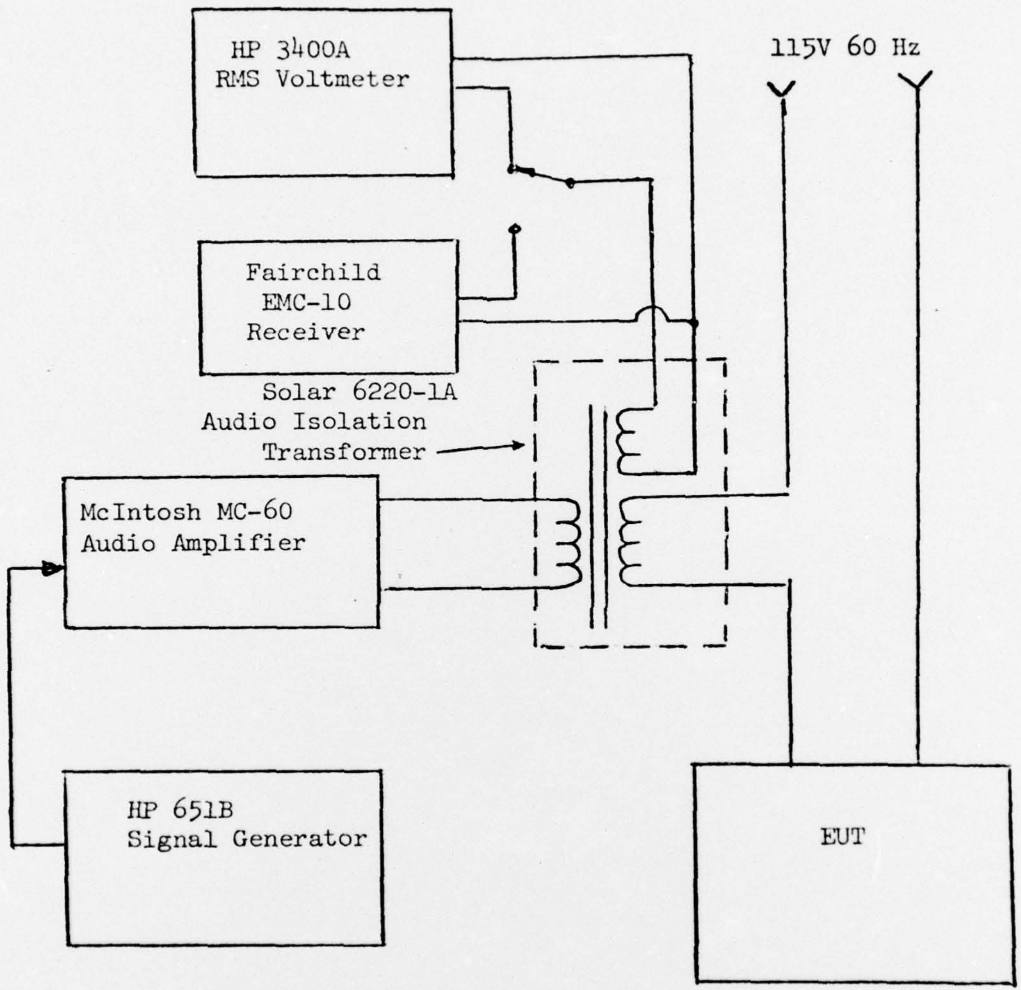
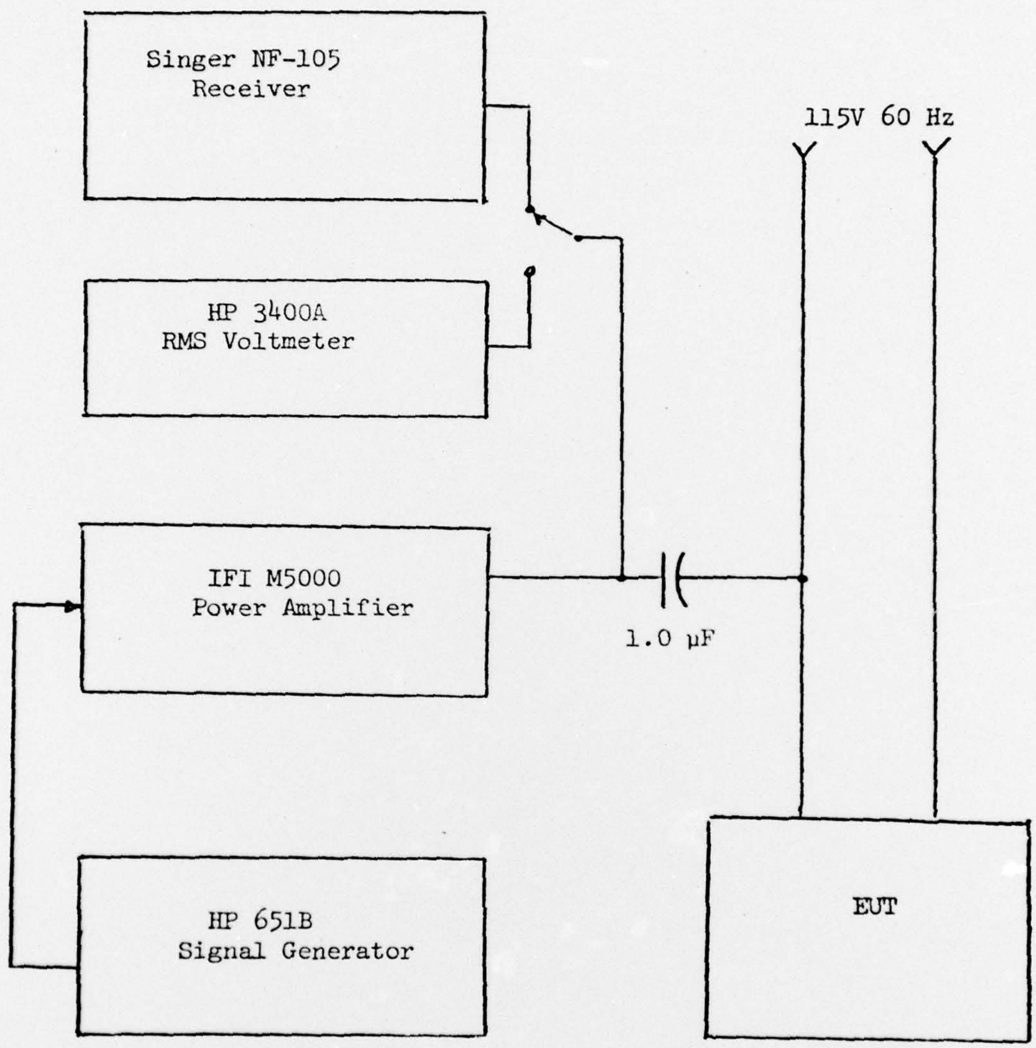


Figure 1. Walk Through Weapon Detector Setup for Susceptibility Tests



NOTE: Typical test of one power line

Figure 2. CS01 Test Setup Block Diagram

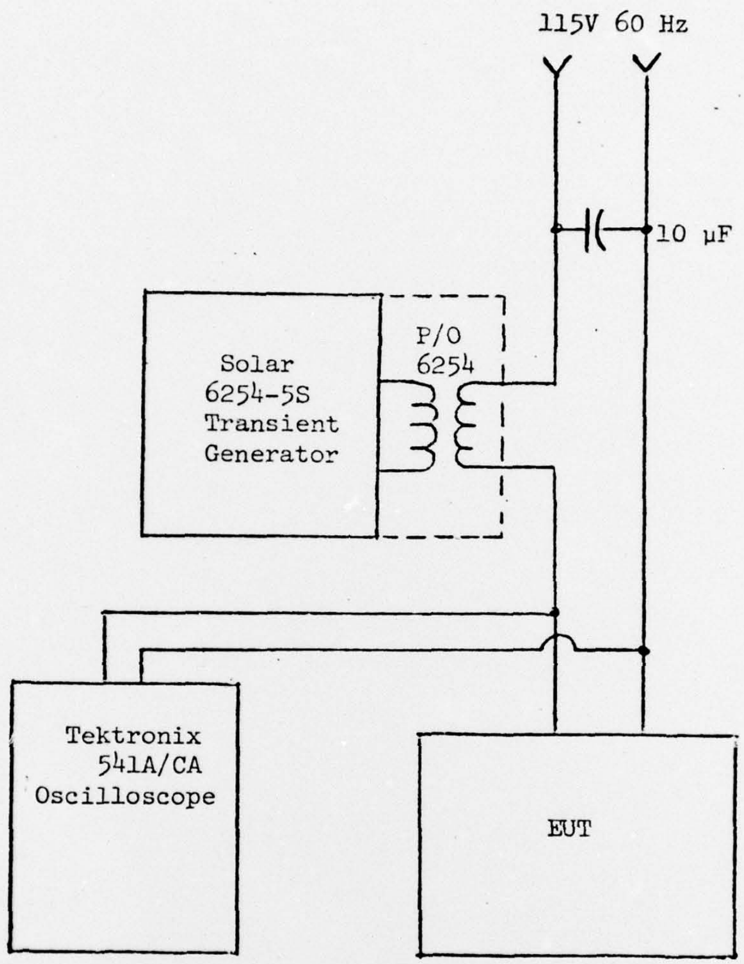


NOTES: 1. Typical of one power line

2. X_C of Capacitor @ 50 kHz = 3 ohms

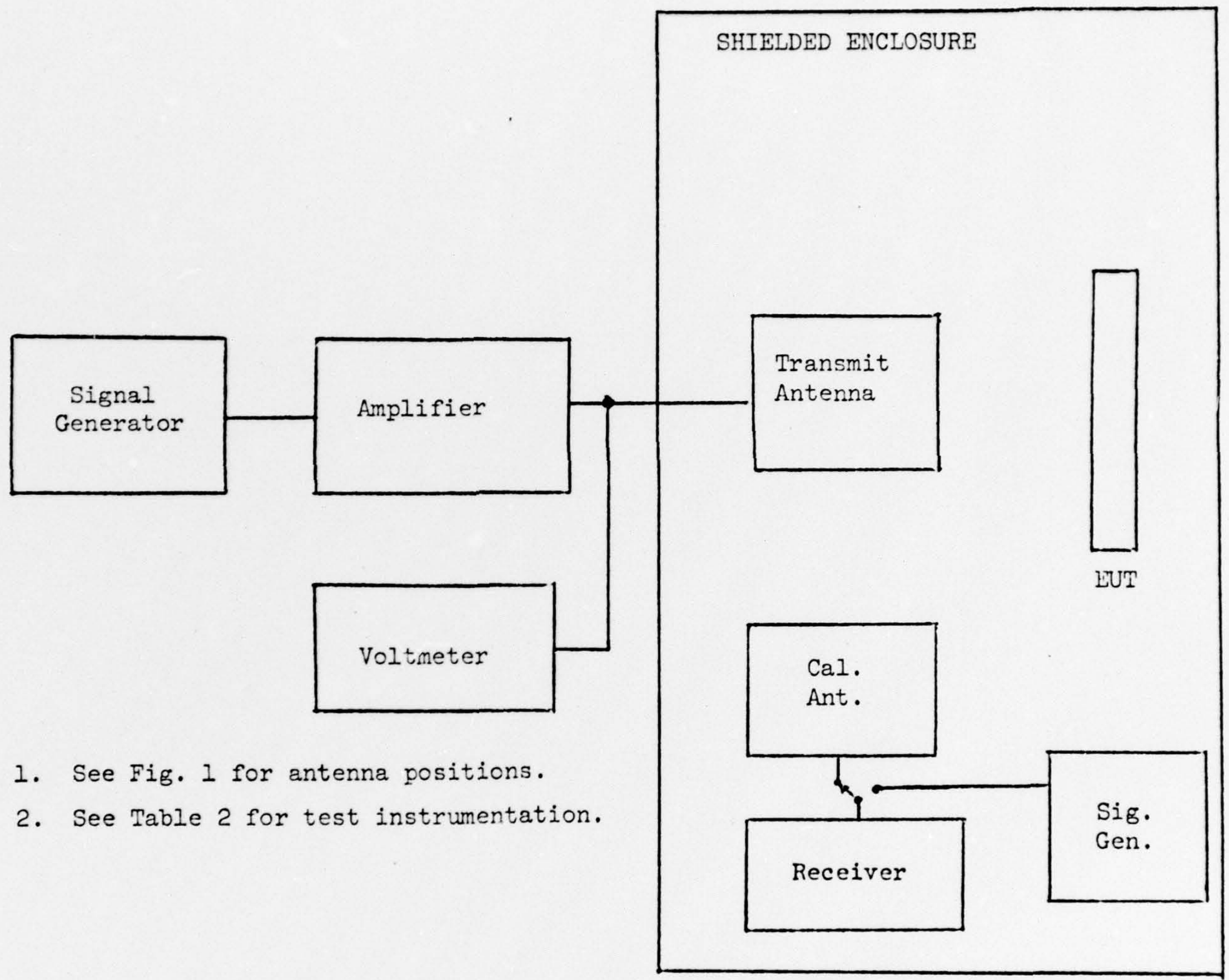
3. X_C of Capacitor @ 400 kHz = 0.4 ohms

Figure 3. CS02 Test Setup Block Diagram



NOTE: Typical test of one power line

Figure 4. CS06 Test Setup Block Diagram



NOTES: 1. See Fig. 1 for antenna positions.

2. See Table 2 for test instrumentation.

Figure 5. RS03 Test Setup Block Diagram